

Ford Allen Park Clay Mine

MID 980568711

Section B Facility Description 40 CFR 270.14 (b) (1)

This section provides a general description of the hazardous waste management facility of the Allen Park Clay Mine (APCM). APCM is applying for a RCRA permit as a disposal facility.

General Description 40 CFR 270.14(b)(1)

The Allen Park Clay Mine (APCM) landfill is located in Wayne County, Michigan within the city limits of Allen Park and is bounded by Oakwood Boulevard, Interstate 94, Outer Drive, Snow Road, and M-39 (Southfield Freeway). Refer to Attachments 1 and 2.

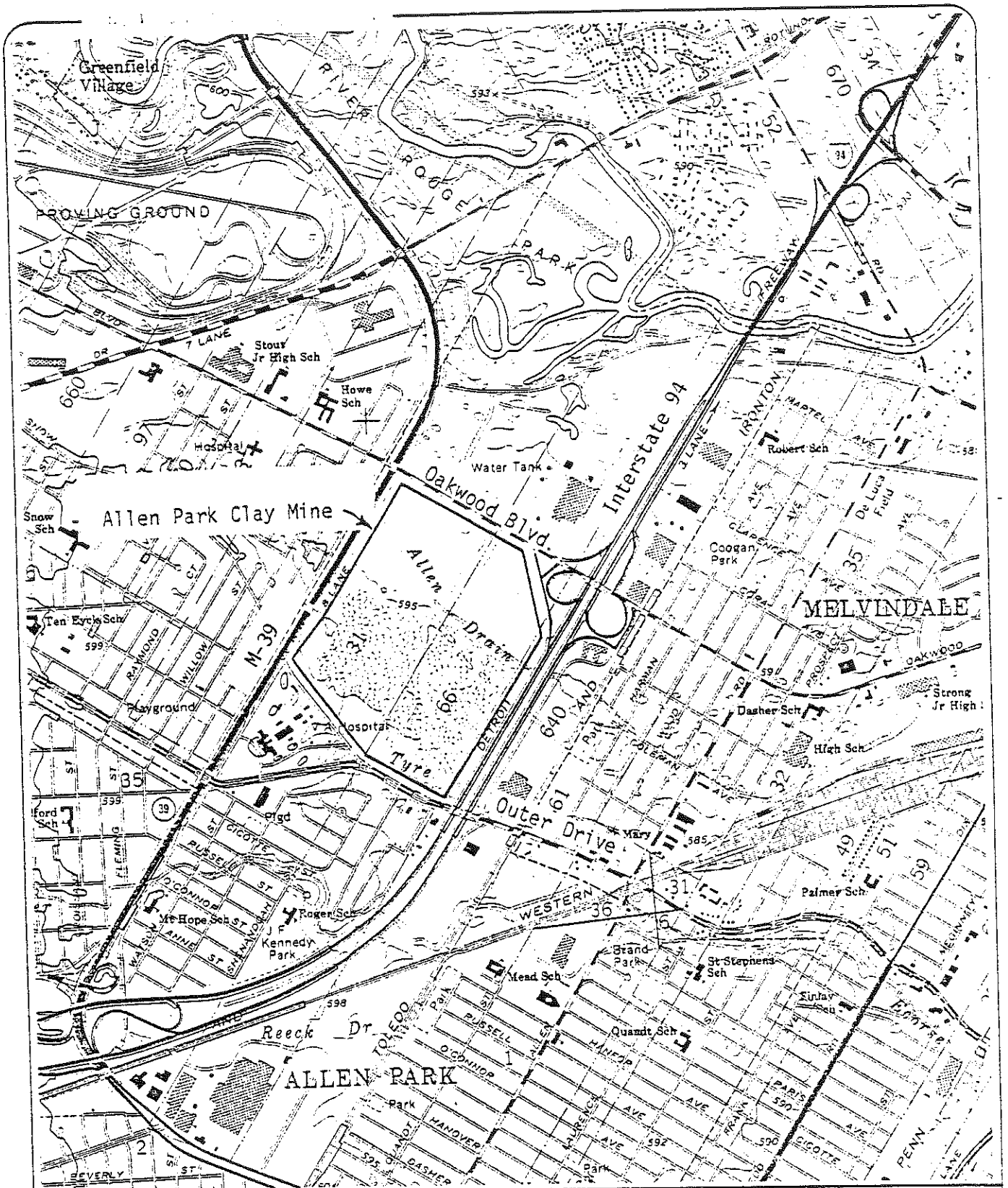
The site is owned and operated by the Ford Motor Company. The hazardous wastes proposed for landfiling at the site are expected to be generated at Ford facilities and will probably be transported to the site by Ford vehicles. This "in-house" operation provides for tight control of waste management activities since Ford handles the wastes from "cradle to grave".

Site Development

Ford Motor Company started site development prior to 1956 for the purpose of mining clay reserves for use in the brick making and cement industries. Cognizant that the site had the ideal geologic formation for a secure landfill, the clay excavations were subsequently back-filled with Ford Motor Company wastes from the Rouge Complex. Ecorse Township issues a permit for the operation on approximately 200 of the 260 acres, the remaining 60 acres of which were designated as greenbelt. Mining and filling continued for 24 years before the enactment of RCRA and Michigan Act 64. On November 19, 1980, the hazardous wastes were segregated and separately landfilled in the designated hazardous waste management area shown on Attachment 3. Clay mine and solid waste disposal activities are projected to extend to the year 2000.

FORD ALLEN PARK CLAY MINE
MID980568711
GENERAL SITE LOCATION





0 1000 2000 3000 4000 5000

Scale - Feet
 Contour Interval 5 Feet
 Datum is Mean Sea Level

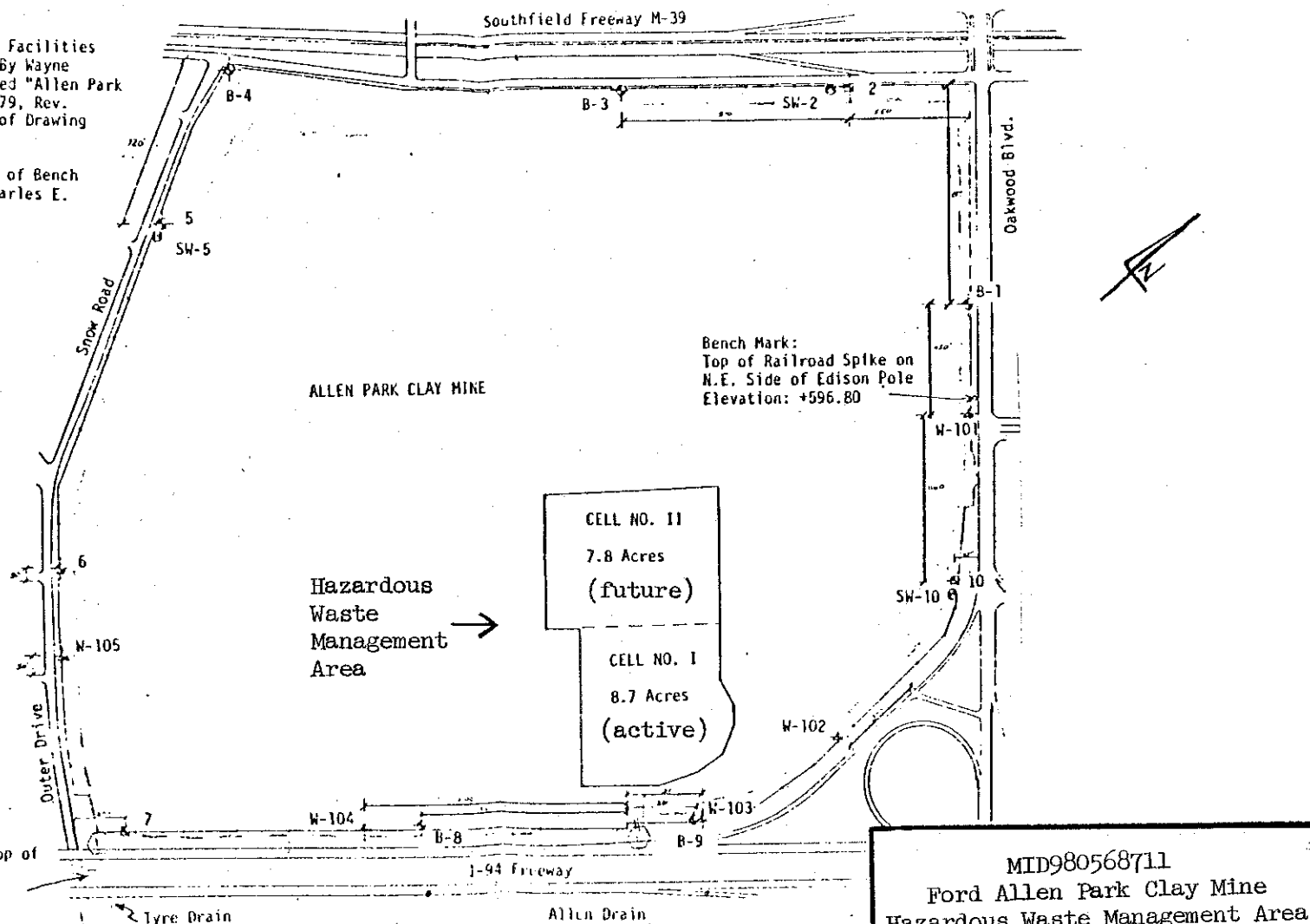
Allen Park Clay Mine
 MID980568711
 Disposal Landfill
 Allen Park, Michigan
 Wayne County

Specific Site Location

Attachment 2

NOTES:

1. General Layout Of Site Facilities
From Drawing Supplied By Wayne
Disposal, Inc., Entitled "Allen Park
Clay Mine" Dated 9-12-79, Rev.
S-1-B1, Sheet No. C-2 of Drawing
No. 79P - 23.6.
2. Location And Elevation of Bench
Marks Obtained From Charles E.
Raines Company



Site Development (Cont'd)

The overall landfill site is composed of approximately 183 acres of solid waste landfill, 17 acres of hazardous waste landfill, 33 acres of greenbelt, and approximately 27 acres have been utilized for easements.

The hazardous waste disposal cells were constructed during the clay mining operation which created a pair of 8 acre excavations that are 35 feet deep. Hazardous waste has filled approximately 25% of Cell I capacity under Interim Status. The area covered by the existing Cell I is shown on Sheets 6 and 7 of the Engineering Drawings (Attachment 14).

Waste types F006, D006, D007, and D008 are included in this application even though samples of the waste are not available for testing and analysis. These waste types will either be generated from newly constructed wastewater treatment plants, processes presently under construction, or possible manufacturing process changes that could result in future hazardous waste designation.

Site Location and Land Use

The site is in the midst of an industrial corridor centered along I-94. Residential areas are located south of Outer Drive and west of Southfield Freeway. West of Snow Road is a Veterans Administration Hospital. North of Oakwood Boulevard is the Ford Motor Company Body and Assembly Operations General Office and Pilot Plant, and a U.S. Postal Service bulk mail distribution center.

Waste Generation

Wastes to be landfilled are:

- . K087 Decanter Coal Tar Sludge from Coking Operations
- . K061 Electric Furnace Emission Control Dust
- . F006 Wastewater Treatment Sludge from Electroplating Operations
- . D006 EP Toxic - Cadmium
- . D007 EP Toxic - Chromium
- . D008 EP Toxic - Lead

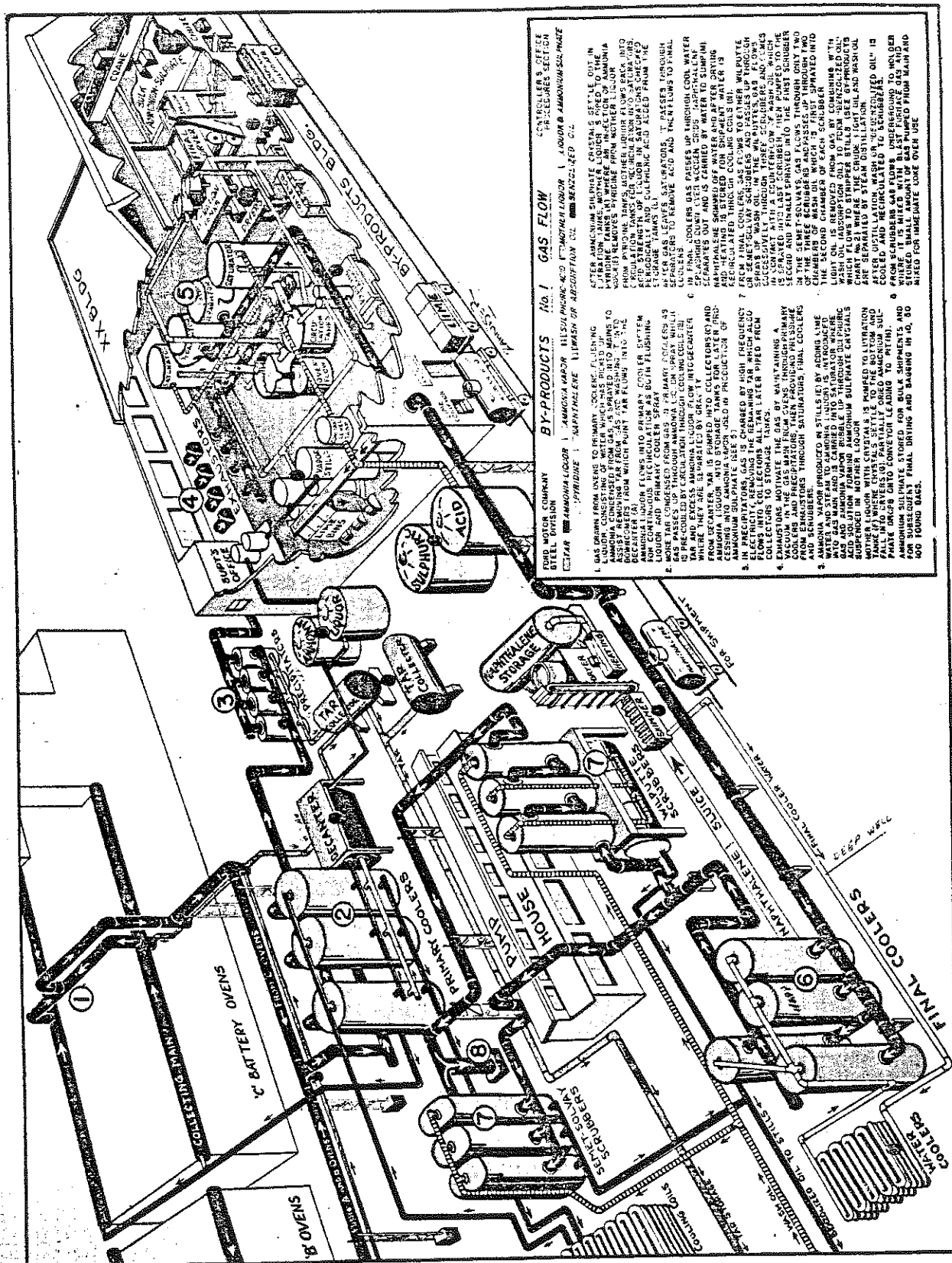
(K087) Decanter Coal Tar Sludge

K087 is generated by the process of spray cooling coke oven gases during the by-product recovery process. Refer to Attachment 4 for further discussion on the generation process. According to the EPA Background Listing Document provided herewith as Attachment 5, the tar sludge is composed approximately of 97% elemental carbon, 2.93% condensed tar materials, .066% naphthalene, and .003% phenolic compounds. The constituents which led to the hazardous listing of K087 are the phenols and naphthalene.

At the present time, Rouge Steel Company generates only 5 cubic yards of K087 per week on a regular basis. Once a week, a Ford Motor Company vehicle (transporter) delivers a 5 yd.³ load to the APCM hazardous waste management cell for disposal. In addition, process tanks are cleaned out annually on a special clean-up basis. Previous annual APCM disposal volumes of K087 are as follows:

1981 - 4,634 Yds.³
1982 - 1,673 Yds.³
1983 - 886 Yds.³

The estimated annual disposal quantity listed in the Part A Application is 5,270 tons.



Ford Allen Park Clay Mine
 MID980568711
 KO87 Generation Process

LISTING BACKGROUND DOCUMENT

K087 Decanter Tank Tar Sludge From Coking Operations

I. Summary of Basis for Listing

The spray cooling of coke oven gases during the by-product recovery process results in the generation of a decanter tank tar-sludge. The Administrator has determined that decanter tank tar-sludge may pose a present or potential hazard to human health or the environment when improperly transported, treated, stored, disposed of or otherwise managed, and therefore should be subject to appropriate management requirements under Subtitle C of RCRA. This conclusion is based on the following considerations:

1) The tank tar-sludge contains significant concentration of phenol and naphthalene. Phenol and naphthalene are toxic to humans and aquatic life.

2) Phenol has leached in significant concentration from a waste sample tested in a distilled water extraction procedure. Although no leachate data is currently available for naphthalene, the Agency believes that, due to its presence in the tar in high concentrations and due to its relative solubility, naphthalene also may leach from the waste in harmful concentrations if the waste is improperly managed.

3) These tar-sludges are often land disposed in on-site landfills or dumped in the open. These methods may be inadequate to impede leachate migration and resulting groundwater contamination.

*The listing description has been amended from that originally proposed on December 18, 1978 (43 FR 58959) which included two waste listings [i.e., Coking: Decanter tank tar and Coking: Decanter tank pitch/sludge]

Additional information substantiating the hazards associated with polynuclear aromatic hydrocarbon constituents in this waste will be evaluated in an expanded listing background document for an integrated by-product coke-making process.

II. Waste Generation, Composition and Management

Coke, the residue from the destructive distillation of coal, serves as both a fuel and as a reducing agent in the making of iron and steel. Some coke plants recover by-products given off or created during the coke production process, and the recovery of by-products generates a sludge which is the listed waste in this document. There are 66 by-product coke plants, which generate an estimated 72,300 tons/yr of decanter tank tar-sludge. During the recovery of chemicals in the by-product coke production process, tar separates by condensation from coke oven gas and drains to a decanter tank. Recoverable oil fractions are decanted off the top and the tar sludge settles to the bottom.

Approximately 97% of this tar-sludge is elemental carbon. The remaining 3% consists of condensed tar materials. These condensed tar materials contain the waste constituents of concern, namely phenolic compounds and naphthalene, which are formed as a result of the destructive distillation of coal.

Based on a published reference, the condensed tar component contains, by weight, 2.2% naphthalene and 0.1% phenolic compounds(2). With an estimated 2,169 tons/yr of condensed tar contained in the amount of tar-sludge generated annually (i.e., 3% of the 72,300 tons/yr of tar-sludge), approximately 47.7 tons of naphthalene and 2.2 tons of phenolic compounds will be contained in the waste generated each year(1,2).

Of the 66 coke plants generating decanter tank tar-sludge, 30 plants use the tar-sludge as a raw material in either the sintering process or open hearth furnace operation. The remaining 36 plants dispose of this waste in unsecure on-site landfills⁽¹⁾, or by dumping in the open⁽³⁾.

III. Hazardous Properties of the Waste

Phenol and naphthalene are present in the tar component of this waste in significant concentrations: 0.1% by weight (1000 ppm) and 2.2% by weight (22,000 ppm), respectively⁽²⁾. Phenol and naphthalene are toxic to humans and aquatic life. Thus, the Agency believes that the concentrations of these materials in the waste are quite significant, in light of the constituents' known health hazards. Further, these waste constituents appear capable of migrating in significant concentrations if mismanaged, and are likely to be mobile and persistent so that waste mismanagement could result in a substantial human health or environmental hazard.

Phenol's potential for migration from this waste in significant concentrations has been demonstrated empirically. Phenol leached in significant concentration (approximately 500 ppm) from a decanter tar-sludge waste sample subjected to distilled water extraction procedure.⁽³⁾ In addition, phenol is extremely soluble, about 67,000 ppm @ 25°C⁽⁵⁾, indicating high potential for migration. Phenol biodegrades at a moderate rate in surface water and soil but moves very

readily (App. B). Even with a persistence of only a few day, the rapid spreading of phenol could cause widespread contamination of the eco-system and contamination of potable water supplies.

The migratory potential of phenol and its ability to move through soils is further confirmed by the fact that it has been detected migrating from Hooker Corporation's S Area, Hyde Park, and 102nd St. landfills in Niagara, New York (OSW Hazardous Waste Division, Hazardous Waste Incidents, Open File, 1978). The compound's persistence following migration is likewise shown by these incidents.

Although no comparable leachate data is currently available for naphthalene, the Agency believes that this constituent also may leach in harmful concentrations from the waste if not properly managed. The water solubility of naphthalene has been reported to range from 30 to 40 mg/l, depending on the salinity of the dissolving medium (7). Naphthalene has been identified in finished drinking water, lakes, and rivers, demonstrating its persistence and mobility (4). This information, naphthalene's solubility in water, and its presence in the tar in such high concentrations (22,000 ppm) make it likely that it will leach from the waste in potentially harmful concentrations if the waste is mismanaged, and will then be mobile and persistent, and so poses the potential for causing substantial hazard to human health and the environment.

Current practices of disposing of this waste in fact appear inadequate. Disposal of decanter tank tar-sludge in unsecured landfills or by dumping in the open makes it likely

that the hazardous constituents in the waste will leach out and migrate into the environment, possibly reaching and contaminating drinking water sources. Siting of waste management facilities in areas with highly permeable soils could facilitate leachate migration. As demonstrated above, the waste constituents appear capable of migration, mobility and persistence. Thus, if disposal sites are improperly managed or designed (e.g., lack adequate leachate collection systems), waste constituents could leach into soils and contaminate groundwater.

Health and Ecological Effects

Phenol

Congress designated phenol a priority pollutant under §307(a) of the Clean Water Act.

Phenol is readily absorbed by all routes. It is rapidly distributed to mammalian tissues. This is illustrated by the fact that acutely toxic doses of phenol can produce symptoms within minutes of administration regardless of the route of entry. Repeated exposures to phenol at high concentrations have resulted in chronic liver damage in humans.(3) Chronic poisoning, following prolonged exposures to low concentrations of the vapor or mist, results in digestive disturbances (vomiting, difficulty in swallowing, excessive salivation, diarrhea), nervous disorders (headache, fainting, dizziness, mental disturbances), and skin eruptions(4).

Chronic poisoning may terminate fatally in some cases where there has been extensive damage to the kidneys or liver.

The Office of Water Regulations and Standards, U.S. EPA(6) has found that acute and chronic toxicity of phenol to freshwater aquatic life occur at concentrations as low as 10,200 and 2,560 ug/l, respectively, and would occur at lower concentrations in more sensitive species than those tested. The available data for phenol indicate that acute toxicity to saltwater aquatic life occurs at concentrations as low as 5,800 ug/l and would occur at lower concentrations among species that are more sensitive than those tested. Based on available toxicity data, the ambient water quality criteria level for phenol to protect human health is 3.5 mg/l. The ambient water criteria level to control undesirable taste and odor qualities, the estimated level is 0.3 mg/l.

OSHA has set a TLV for phenol at 5 ppm. Phenol is listed in Sax's Dangerous Properties of Industrial Materials as highly toxic via an oral route.(4) Sax also describes phenol as a co-carcinogen and a demonstrated carcinogen via a dermal route in studies done with laboratory animals. Additional information and specific references on the adverse effects of phenol can be found in Appendix A.

Naphthalene

Naphthalene is designated as a priority pollutant under Section 307(a) of the CWA.

Systemic reaction to acute exposure to naphthalene includes nausea, headache, diaphoresis, hematuria, fever, anemia, liver damage, convulsions and coma. Industrial exposure to naphthalene appears to cause increased incidence of cataracts. Also, hemolytic anemia with associated jaundice and occasionally renal disease from precipitated hemoglobin has been described in newborn infants, children, and adults after exposure to naphthalene by ingestion, inhalation, or possibly by skin contact.

The Office of Water Regulations and Standards, U.S. EPA(7) has found that acute and chronic toxicity to freshwater aquatic life occur at concentrations as low as 2,300 and 620 ug/l, respectively, and would occur at lower concentrations among species that are more sensitive than those tested. The available data for naphthalene indicate that acute toxicity to saltwater aquatic life occurs at concentrations as low as 2,350 ug/l and would occur at lower concentrations among species that are more sensitive than those tested. Using the present guidelines, a satisfactory criterion for ambient water quality could not be derived at this time because of the insufficiency of data for naphthalene.

OSHA's standard for exposure to vapor for a time-weighted industrial exposure is 50 mg/m³.

Sax lists naphthalene as moderately toxic via the oral route and warns that naphthalene is a demonstrated neoplastic

substance via the subcutaneous route in experiments done on laboratory animals(4). Additional information and specific references on the adverse effects of naphthalene can be found in Appendix A.

REFERENCES

K087: Coking:Decanter Tank Car Sludge.

1. U.S. EPA. Draft Development document for proposed effluent limitations guidelines and standards for the iron and steel manufacturing point source category; by-product cokenaking subcategory, v.2 EPA No. 440/1-79 024a. October 1979.
2. Desha, L. Organic chemistry. McGraw-Hill Book Company, New York. 1946.
3. Calspan Corporation. Assessment of industrial hazardous waste practices in the metal smelting and refining industry, v.3. Appendices. Contract No. 68-01-2604. April 1977.
4. Sax, N.I. Dangerous properties of industrial materials, Van Nostrand Reinhold Co., New York. 5th ed., 1979.
5. Dawson, English and Petty. Physical chemical properties of hazardous waste constituents. Appendix C of the May 2, 1980 listing background documents. 1980
6. U.S. EPA. Ambient water quality criteria for phenol. EPA No. 440/5-80-066. NTIS PB No. 81-117772. October 1980.
7. U.S. EPA. Ambient water quality criteria for naphthalene. EPA No. 440/5-80-059. NTIS PB No. 81-117707. October 1980.

Response to Comments: Coking - Decanter Tank Tar/Sludge.

One commenter stated that the Agency has misstated the scientific evidence for the waste constituents phenol and naphthalene with respect to attributing potential carcinogenicity to these two constituents.

The Agency agrees with the commenter and has revised the listing background document in a manner consistent with the toxicological analyses contained in Appendix A - Health and Environmental Effects Profiles of Subtitle C - Identification and Listing of Hazardous Waste, RCRA. However, the Agency still believes that these contaminants exhibit sufficient toxicity to be of regulatory concern. More specifically, prolonged exposure to low concentrations of phenol can result in digestive disturbances, nervous and skin disorders. Similar exposure to naphthalene can cause liver and renal disease.

(K061) Electric Furnace Emission Control Dust

K061 is generated from the primary production of steel in electric furnaces when particulate matter in the off gas is collected by air pollution control equipment (baghouse). The composition of the K061 dust is basically made up of iron, calcium and manganese oxides. The constituents which led to the hazardous listing of K061 are the oxides of lead, chromium and cadmium which are present due to the quantity of steel scrap charge containing galvanized metals. For the EPA background document which provides the rationale for the K061 hazardous waste listing, refer to Attachment 6.

At the present time, Rouge Steel Company generates up to 500 tons of K061 per week on a regular basis. However, the material is currently utilized in an offsite commercial liquid waste treatment process, and only special clean-up waste is disposed of at APCM.

1981 - 6,259 Yds.³

1982 - 469 Yds.³

1983 - 60 Yds.³

The estimated annual disposal quantity listed in the Part A Application is 19,074 tons, which is consistent with our in-force Michigan Act 64 Operating License.

(F006) Wastewater Treatment Sludge From Electroplating Operations

These sludges will be generated from the following Ford facilities:

- . Brownstown Parts Distribution Center
- . Dearborn Assembly/Frame Plant
- . Rawsonville
- . Saline
- . Sheldon Road

ELECTRIC FURNACE PRODUCTION OF STEEL

K061 emission control dust/sludges from the primary production of steel in electric furnaces (T)*

Summary of Basis for Listing

Emission control dusts/sludges from the primary production of steel in electric furnaces are generated when particulate matter in the gases given off by electric furnaces during the production process is removed by air pollution control equipment. Dry collection methods generate a dust; wet collection methods generate a sludge. The Administrator has determined that these dusts/sludges are solid wastes which may pose a present or potential hazard to human health and the environment when improperly transported, treated, stored, disposed of or otherwise managed and therefore should be subject to appropriate management requirements under Subtitle C of RCRA.

This conclusion is based on the following considerations:

- (1) The emission control dusts/sludges contain significant concentrations of the toxic metals chromium, lead, and cadmium.
- (2) Lead, chromium and cadmium have been shown to leach in harmful concentrations from waste samples subjected to both a distilled water extraction procedure and the extraction procedure described in 6250.13(d) of the proposed Subtitle C regulations.

*This listing was originally proposed on December 18, 1978 (FR 58959) under SIC Code 3312 and states as "Iron Making: Electric furnace dust and sludge." In response to a comment submitted by the American Iron and Steel Institute that the electric furnace process is used for steelmaking only, not iron and steelmaking as was previously listed, the Agency modified the listing on May 19, 1980 (45 FR 33124) as "Emission control dusts/sludges from the electric furnace production of steel." In further response to a comment submitted by the American Foundryman's Society, the Agency is again modifying the listing to make it clear that this listing is meant to apply to primarily steel producers only (see Response to Comments in back of this document for more detailed discussion).

- (3) A large quantity of these wastes (a combined total of approximately 337,000 metric tons) is generated annually and is available for disposal. There is thus a likelihood of large scale contamination of the environment if these wastes are mismanaged.
- (4) The wastes typically are disposed of by being dumped in the open, either on-site or off-site, thus posing a realistic possibility of migration of lead, cadmium, and chromium to underground drinking water sources. These metals persist virtually indefinitely, presenting the serious threat of long-term contamination.
- (5) Off-site disposal of these wastes will increase the risk of mismanagement during transport.

I. Profile of the Industry

The electric furnace (arc) process is one of the three principal methods of producing steel in the United States. In 1974, the iron and steel industry had the capacity to produce approximately 27,000,000 metric tons/year of steel via the electric furnace process (1).

Plants are located in 31 different states, with 70% of the estimated capacity located in Ohio, Pennsylvania, Illinois, Texas, Michigan and Indiana (1). A typical integrated electric furnace steel plant has an electric furnace capacity of about 500,000 metric tons/yr (1). Capacities at different plants range from about 50,000 to 2,000,000 metric tons/yr (2).

II. Manufacturing Process

The raw materials for the electric arc steelmaking process include cold iron and steel scrap, and fluxes such as limestone and/or fluorspar. The raw materials are charged into a refractory-lined cylindrical furnace and melted by

passing an electric current (arcing) through the scrap steel by means of three triangularly spaced carbon electrodes inserted through the furnace roof. The process proceeds at high temperatures and an oxidizing atmosphere (air or pure oxygen are used).(2) The electrodes are consumed at a rate of about 5 to 8 kg/kg of steel, with the emission of CO and CO₂ gases. The hot gases entrain finely divided particulate, 70% of which (by weight) are less than 5 microns in size, the majority of this less than 0.5 microns. The particulate fume or dust consists primarily of iron oxides, silica and lime, with significant concentrations of the toxic metals lead, chromium and cadmium (1).

III. Waste Generation

The waste products from the electric carbon furnace process is a mixture of gases consisting of smoke, slag, carbon, nitrogen, ozone and oxides of iron as well as other metals. (2) The particulates produced during the electric furnace steelmaking process are removed from the furnace off-gases by means of baghouse filters, electrostatic precipitators, or high-energy Venturi scrubbers. The baghouse filters and electrostatic precipitators, which are used by 93% of electric arc steelmaking furnaces, produce an emission control (dry) dust for disposal at a rate of 12.8 kg of dust per metric ton of steel produced. Scrubbers, used by the remaining 7% of the steelmaking industry, produce slurries or sludges for disposal at a rate of about 8.7 kg (dry solids

basis) per metric ton of steel produced.

Based on an electric furnace steelmaking capacity of 27,000,000 kkg/yr (see p. 2 above), and assuming that the electric furnaces that use dry air pollution control equipment represent 93% of that capacity, the industry-wide estimated quantities of emission control dusts and sludges produced at full operating capacity are 321,000 kkg/yr, and 16,000 kkg/yr (dry solids basis), respectively.

The Agency has information indicating that these wastes are typically dumped in the open at on-site or off-site disposal facilities (1,2). The emission control sludges, however, are also amenable to other forms of disposal, such as disposal in lagoons or surface impoundments. The large quantities of these wastes generated annually, combined with the fact that other emission control dusts/sludges generators handle their wastes in this manner, make this type of management situation plausible. (See, for example, Secondary Lead Hazardous Waste Listing Background Document).

IV. Hazardous Properties of the Wastes

1. Migrating Potential of Waste Constituents

An analysis of the electric furnace dust supplied by U.S. Steel Corporation is given in Table 1 (3). As the data indicate, two of the toxic metals of concern, lead and chromium are present in significant concentrations. Lead, for example, which has a usual range of lead-in-soil concentrations of 2

to 200 ppm (4), is present in this waste sample at a concentration of 1,400 ppm.*

Another analysis of waste samples from both electric furnace dusts and sludges also shows lead and chromium to be present in the wastes in significant amounts. The analysis of the emission control dust waste sample revealed chromium to be present at 1380 ppm and lead to be present at 24,220 ppm. The analysis of the emission control sludge sample revealed total chromium to be present in the waste at 2,690 ppm and lead at 7,900 ppm (1).

The metal oxide particulates in these dusts are formed at high temperatures in an oxidizing atmosphere. Such conditions are known to result in the oxidation of chromium to its hexavalent form.(16) The dusts and sludges, therefore, are presumed to contain hexavalent chromium compounds.

The presence of such high concentrations of lead and (presumably hexavalent) chromium in this waste stream, in and of itself, raises regulatory concerns. Furthermore, the Agency has data see table 2, p. 8) from the proposed EPA Extraction Procedures (Samples 1-4) and an industry-conducted water extraction (Sample 5) which show that lead, chromium and cadmium may

*The absence of cadmium from the waste sample described in Table 1 may be attributable to the fact that 29% of the constituents (by weight) of the waste sample are not accounted for, or the fact that the composition of electric furnace dust can vary considerably depending on the type and quantity of cold scrap used to charge the furnace. Cadmium is a demonstrated waste constituent as evidenced by its presence in significant concentrations in the leachate tests on electric furnace dusts shown in Table 2 below.

Table 1

Composition of an Electric Furnace Dust*

<u>Parameter</u>	<u>Weight %</u> (not intended to total 100%)
Fe (total)	35.34
MnO	8.29
SiO ₂	5.61
Al ₂ O ₃	0.62
CaO	12.01
Cr ₂ O ₃	2.69
CuO	0.12
Ni	0.59
Pb	0.14
Zn	0.39
F	<u>5.09</u>
Total	70.89

Source: Reference 3

*Although the data in Table 1 is presented for the electric furnace dusts collected by baghouse filters or electric precipitators and not for the sludges produced by Venturi scrubbers, the solids composition of the sludges produced by scrubbers can be assumed to be virtually the same as that of the electric furnace dusts since both wet and dry air pollution systems entrain the same heavy metal particulate.

leach from electric furnace dusts in significant concentrations. In view of the relative insolubility of trivalent chromium (see Attachment 1), the demonstrated leaching of chromium in these tests points to the probable presence in these wastes of hexavalent chromium. All of the waste extracts--either by the EPA EP procedure which uses acetic acid as its leaching solution, or by the industry test which uses distilled water--contain contaminants in concentrations which are either equal to or, for the most part, exceed EPA's National Interim Primary Drinking Water Standards, in some instances by several orders of magnitude. The distilled water extraction shown in Sample 5 of Table 2 indicates that these wastes may leach harmful concentrations of lead, cadmium, and (presumably hexavalent) chromium even under relatively mild conditions.

This conclusion is further supported by different solubility tests done on electric furnace emission control dust waste samples, also using water as the leaching medium (1). In this test, lead was again found to leach at dangerous concentrations, e.g. 150 ppm. Another water solubility test done on an electric furnace sludge waste sample likewise showed chromium and lead to leach from the sludge in significant concentrations of 94 ppm and 2.0 ppm, respectively (1).

If these wastes are exposed to more acidic environments (landfills or disposal environments subject to acid rainfall) these metals' concentrations in leachate would likely be higher, since most compounds of lead, cadmium, and chromium are more soluble in acid than in distilled water (5,6,7).

Table 2.

Leach Test Results (mg/l) on Electric Furnace Emission Dusts

<u>Contaminant</u>	<u>National Interim Primary Drinking Water Standard</u>	<u>Sample 1*</u>	<u>Sample 2*</u>	<u>Sample 3*</u>	<u>Sample 4*</u>	<u>Sample 5**</u>	<u>Sample 6***</u>
Cd	0.01	0.03	2.84	3.85	4.8-13.4	3.5	-
Cr	0.05	<0.1	0.48	-	0.05	1,248.0	120.0
Pb	0.05	0.5	0.06	36.7	<0.2	0.3	.16

*EP extraction data submitted by an American Iron and Steel Institute letter to John P. Lehman from Earle F. Young, Jr., dated May 15, 1979.

**Waste Characterization Data for the State of Pennsylvania, Department of Environmental Resources. The data for Sample 5 was supplied by Allegheny Ludlum Steel Corporation from a water extraction procedure. The apparent discrepancy between the result obtained for chromium in Sample 5 and those obtained for chromium in Samples 1-4 may be attributable to the particular type and quantity of scrap metal used in the steelmaking processes which produced these waste samples.

***Source: Reference 1 water extraction.

Many of the states in which the majority of these wastes are generated, including Ohio, Pennsylvania, Illinois and Indiana, are known to experience acid rainfall (8).

A further indication of the migratory potential of the waste constituents is the physical form of the waste itself. These waste dusts/sludges are of a fine particulate composition, thereby exposing a large surface area to any percolating medium, and increasing the probability for leaching of hazardous constituents from the waste to groundwater.

2. Substantial Hazard from Waste Mismanagement

In light of the demonstrated migratory potential of harmful concentrations of the waste constituents, improper management of these wastes could easily result in the release of contaminants. For instance, selection of disposal sites in areas with permeable soils can permit contaminant-bearing leachate from the waste to migrate to surface water and/or groundwater. The possibility of groundwater contamination is especially significant with respect to disposal of these wastes in surface impoundments, since a large quantity of liquid is available to percolate through the solids and soil beneath the fill.

An overflow problem might also be encountered if these wastes are ponded and the liquid portion of the waste has been allowed to reach too high a level in the lagoon; a heavy rainfall could cause flooding which might result in the contamination of soils and surface waters in the vicinity.

In addition to difficulties caused by improper site selection, unsecure landfills in which dusts and dredged solids could be disposed of are likely to have insufficient leachate control practices. There may be no leachate collection and treatment system to diminish leachate percolation through the wastes and soil underneath the site to groundwater and there may not be a surface run-off diversion system to prevent contaminants from being carried from the disposal site to nearby surface waters.

In addition to ground and surface water contamination, airborne exposure to lead, chromium, or cadmium particulate escaping from mismanaged emission control dusts is another pathway of concern. These minute particles could be dispersed by wind if waste dusts are piled in the open, placed in unsecure landfills or improperly handled during transportation. As a result, the health of persons who inhale the airborne particulates would be jeopardized. This is especially true for hexavalent chromium compounds, whose carcinogenicity via inhalation is especially well substantiated.

Transportation of these wastes to off-site disposal facilities increases the likelihood of their causing harm to human beings and the environment. The mismanagement of these wastes during transportation may thus result in an additional hazard. Furthermore, absent proper management safeguards, the wastes might not reach the designated destination at all, thus making them available to do harm elsewhere.

The lead, chromium and cadmium that may migrate from the waste to the environment as a result of such improper disposal practices are elemental metals that persist indefinitely in the environment in some form. Therefore, contaminants migrating from these wastes may pollute the environment for long periods of time.

3. Justification for T Listing

The Agency has determined to list emission control dusts/sludges from the primary production of steel in electric furnaces as a T hazardous waste on the basis of lead, chromium and cadmium constituents, although these constituents are also measurable by the E toxicity characteristic. Although concentrations of these constituents in an EP extract from waste streams from particular sites may not always be greater than 100 times the National Interim Primary Drinking Water Standards, the Agency believes that there are factors in addition to metal concentrations in leachate which justify the T listing. Some of these factors have already been identified, namely the high concentrations of cadmium, chromium and lead in the actual waste and in leachate samples, the non-degradability of these substances, and the strong possibility of the lack of proper management of the wastes in actual practice.

The quantity of these wastes generated is an additional supporting factor. As indicated above, electric furnace emission control dusts/sludges are generated in very substantial quantities, and contain high concentrations of the

toxic metals lead, chromium and cadmium. Large amounts of each of these metals are available for environmental release. The large quantities of these contaminants pose the danger of polluting large areas of ground or surface waters. Contamination could also occur for long periods of time, since large amounts of pollutants are available for environmental loading. Attenuative capacity of the environment surrounding the disposal facility could also be reduced or used up due to the large quantities of pollutant available. All of these considerations increase the possibility of exposure to the harmful constituents in the wastes, and in the Agency's view, support a T listing.

V. Hazards Associated with Lead, Chromium, and Cadmium

Lead is poisonous in all forms. It is one of the most hazardous of the toxic metals because it accumulates in many organisms, and its deleterious effects are numerous and severe. Lead may enter the human system through inhalation, ingestion or skin contact. Hexavalent chromium is toxic to man and lower forms of aquatic life. Cadmium is also a cumulative poison, essentially irreversible in effect. Excessive intake leads to kidney damage, and inhalation of dusts also damages the lungs. Additional information on the adverse health effects of lead, chromium, and cadmium can be found in Appendix A.

The hazards associated with exposure to lead, chromium, and cadmium have been recognized by other regulatory programs.

Lead, chromium and cadmium are listed as priority pollutants in accordance with §307(a) of the Clean Water Act of 1977. Under §6 of the Occupational Safety and Health Act of 1970, a final standard for occupational exposure to lead has been established and a draft technical standard for chromium has been developed (9, 10). Also, a national ambient air quality standard for lead has been announced by EPA pursuant to the Clean Air Act (9). In addition, final or proposed regulations of the State of California, Maine, Massachusetts, Minnesota, Missouri, New Mexico, Oklahoma and Oregon define chromium and lead containing compounds as hazardous wastes or components thereof (11).

EPA has proposed regulations that will limit the amount of cadmium in municipal sludge which can be landspread on cropland (12). The Occupational Safety and Health Administration (OSHA) has issued an advance notice of proposed rulemaking for cadmium air exposure based on a recommendation by the National Institute for Occupational Safety (13). EPA has also prohibited the ocean dumping of cadmium and cadmium compounds except when present as trace contaminants (14). EPA has also promulgated pretreatment standards for electroplaters which specifically limit discharges of cadmium to Public Owned Treatment Works (15).

References

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2. U.S. EPA. Development document for proposed effluent limitations guidelines and standards for the iron and steel manufacturing point source category, v.5. EPA No. 440/1-79/024a. October, 1979.
3. Waste Characterization Data from the State of Pennsylvania Department of Environmental Resources; letter from P.Y. Masciantonio to T. Orlando, dated September 8, 1975.
4. U.S. EPA. Quality criteria for water. Washington, D.C. 1976.
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11. U.S. EPA State Regulations Files. Hazardous Waste State Programs, Wh-565, U.S. EPA, 401 M St., S.W., Washington, D.C. 20460. Contact Sam Morekas. (202) 755-9145.
12. 44 FR 53449.
13. 42 FR 5434.
14. 38 FR 28610.
15. Federal Register. Vol. 44. No. 175. Friday, September 7, 1979. (40 CFR Part 413).

(FO06) Wastewater Treatment Sludge From Electroplating Operations (Cont'd)

- . Wayne/Michigan Truck
- . Ypsilanti

These hydroxide sludges are produced from electroplating (phosphating) wastewater pretreatment plants. Before accepting any of these sludges, physical and chemical analyses will be performed in accordance with the facility Waste Analysis Plan, in addition to compatibility testing that is necessary.

The estimated maximum annual disposal quantity listed in the Part A Application is 20,000 tons.

(DO06) EP Toxic - Cadmium

This waste exhibits the characteristic of EP toxicity. The particular source of waste might include the Emission Control Dust from the Basic Oxygen Furnace (BOF) in steelmaking operations. This waste is presently neither a hazardous waste based on listing or characteristic. Such dust could have cadmium content due to the increased usage of galvanized scrap into the hot metal charge. The dust would otherwise be very similar to KO61 in chemical and physical properties. Wastewater sludge from the steel galvanizing process or continuous caster might produce this waste in a metal hydroxide form.

(D007) EP Toxic - Chromium

This waste exhibits the characteristic of EP toxicity. The particular source of waste might include the Emission Control Dust from the Basic Oxygen Furnace (BOF) in steelmaking operations. This waste is presently neither a hazardous waste based on listing or characteristic. Such dust could have chromium content due to the increased usage of galvanized scrap into the hot metal charge. The dust would otherwise be very similar to KO61 in chemical and physical properties. Wastewater sludge from the steel galvanizing process or continuous caster might produce this waste in a metal hydroxide form.

(D008) EP Toxic - Lead

This waste exhibits the characteristic of EP toxicity. The particular source of waste might include the Emission Control Dust from the Basic Oxygen Furnace (BOF) in steelmaking operations. This waste is presently neither a hazardous waste based on listing or characteristic. Such dust could have lead content due to the increased usage of galvanized scrap into the hot metal charge. The dust would otherwise be very similar to KO61 in chemical and physical properties. Wastewater sludge from the steel galvanizing process or continuous caster might produce this waste in a metal hydroxide form.

B-2 Topographic Map 40 CFR 270.14(b)(19)

Refer to the Engineering Drawings for the topographic maps covering the area of interest (Attachment 14).

B-2a General Requirements 40 CFR 270.14(b)

The enclosed Engineering Drawings (Attachment 14) provide:

- . facility and distance around it, at a scale of 1" = 200'
- . 2' contours
- . Map date
- . 100 year flood plain
- . surface waters
- . surrounding land uses
- . map orientation
- . legal boundary of facility site
- . location of access control
- . buildings
- . structures
- . sewers
- . unloading areas
- . fire control facilities
- . flood control barriers
- . run off control systems
- . hazardous waste operating units
- . wind rose

B-2b Additional Requirements for Land Disposal Facilities 40 CFR 270.14(c)

As provided by 264.90(b)(4), this facility is not subject to RCRA groundwater monitoring requirements (see Attachment 15, Groundwater Waiver Demonstration), and is therefore not subject to 270.14(c).

B-3b Floodplain Standard 40 CFR 270.14(b)(11)

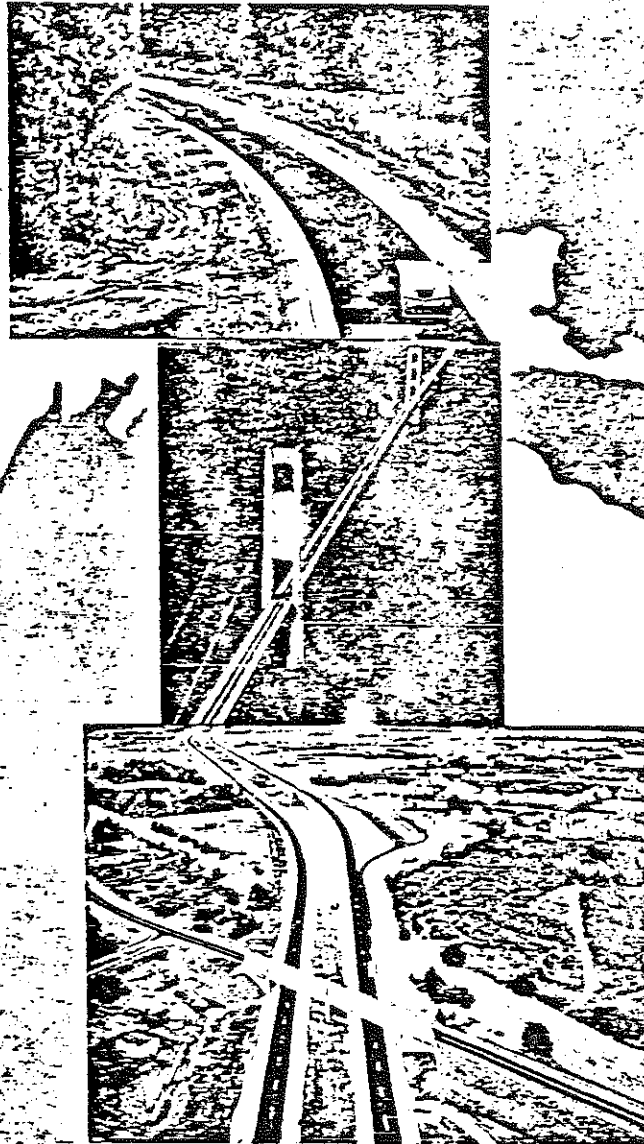
The site is not located within the 100 year floodplain as shown by Flood Insurance Rate Map Panel Number 260217 0002 B effective February 17, 1982 provided with the Engineering Drawings (Attachment 14).

B-4 Traffic Information 40 CFR 270.14(b)(10)

The site access road has supported the transportation of 4 million tons of clay and 8 million tons of waste since 1956. It was built and maintained with steel furnace slag, which provided an excellent subbase for the 25x high stability asphalt mix that was laid down in 1980. This steel furnace slag asphalt mix was laid down in a $2\frac{1}{2}$ inch base course, overlain by $1\frac{1}{2}$ inches of finish course. The specifications for the mix design are shown in Attachment 7 along with the MAPA Design and Construction Guide. Note that the facility belongs under a Traffic Class 7 (Medium-Heavy). The access road has been properly designed and constructed to handle traffic of this magnitude.

As of 1984, there has been no sign of cracking or distress in the asphalt. The pavement is 25' x 1000' with a 25' shoulder on each side. All incoming traffic stops at the end of this access road where the manifest check-in trailer is located. Refer to Attachment 8. Speed limit signs are posted at 15 mph.

Design and Construction Guide



MAPA

MICHIGAN ASPHALT PAVING ASSOCIATION, INC.

705 WASHINGTON SQUARE BUILDING • LANSING, MICH. 48933 • 517-482-0111

FOR WORD

This design and specification guide is intended for the use of counties, cities, consulting engineers and architects for the construction of a modern high type bituminous pavement for county roads, city streets, airports, parking lot driveways, playgrounds, sidewalks, sport facilities, and the resurfacing of existing pavements. The specifications include the Michigan Department of State Highways Specification 4.13, fine aggregate wearing course; high type bituminous concrete surface 4.12; bituminous aggregate pavement 4.11; bituminous aggregate surface 4.09; bituminous base course 3.05; and asphalt curb.

The design recommendations in this manual are based on results of the AASHTO Road Test, specifications of the Michigan Department of State Highways, and data from publications of the National Asphalt Pavement Association, The Asphalt Institute, and the U.S. Corps of Engineers, based on load, traffic volume, soil support and condition of existing surface. Some photos used are through the courtesy of the Michigan Tourist Council and the Michigan Department of State Highways.

DESCRIPTION OF FULL DEPTH HOT MIX ASPHALT PAVEMENT:

This specification covers the newest development in asphalt paving with the use of a hot mix asphalt base and a bituminous concrete or bituminous aggregate wearing course. The use of hot mix asphalt base is now being widely accepted on the basis of recent experience records, and its outstanding performance on the AASHTO Test Road. Hot mix asphalt base has a wide application ranging from light traffic loading on residential driveways and parking areas to heavy duty driveways, roads, shopping centers, and airports. The design thickness of the pavement structure shall be determined by the engineer based on the type of traffic and the load carrying capacity of the subgrade soil. (See thickness chart for "Surface and Hot Mix Asphalt Base.")

Hot mix asphalt base is the term used by the Michigan Asphalt Paving Association to describe a hot mixed asphaltic mixture composed of graded aggregate bound together by asphalt. In different sections of the state, it may also be referred to as black base, deep strength, full depth, total asphalt, or some other terminology.

FACTS ABOUT FULL DEPTH HOT MIX ASPHALT PAVEMENTS:

Long pavement life, free from maintenance will be obtained by placing full depth asphalt pavements on the prepared subgrade. From a structural standpoint, the higher quality of a full depth section over a comparable composite section results from the following:

1. The thicker asphalt sections develop tensile strength in the lower portion of the pavement to resist the stresses of the applied loads.
2. A well designed full depth asphalt pavement results in a waterproof section which will not allow underground water to penetrate the pavement structure, thus minimizing the affects of frost.

ADVANTAGES OF HOT MIX ASPHALT BASE AND SURFACING:

1. Hot mix asphalt pavements can be designed to suit any conditions of traffic, soils, and materials and can be used to salvage old pavements as well as to build new ones.
2. It prevents water accumulation in pavement courses, minimizing the need for costly subsurface drainage.
3. It is durable and has low maintenance cost.
4. It reduces stress on the subgrade.
5. It protects the subgrade from rain during construction, reducing construction delays due to bad weather.
6. It permits haul traffic on the base.
7. It can be constructed rapidly and economically.
8. Snow and ice melt faster on the black surface, making removal easier and more economical.
9. It can be strengthened easily to handle increased loads; phase (stage) construction can be incorporated in design.
10. It is not affected by ice control chemicals.
11. Smoother and quieter riding.

DRAINAGE:

Design for drainage deserves maximum attention. Where high water tables occur or where water may accumulate in low areas, consideration must be given to subsurface drainage. The installation of underdrains and/or interceptor drains may be required to prevent the accumulation of water beneath the pavement structure.

A minimum grade of at least 1% (approximately 1/8" per foot) shall be maintained to provide for adequate drainage of surface water from the finished pavement. Whenever possible, a grade of 1/4" per foot should be used.

On large parking lots, tilted sections, catch basins and storm sewers may be necessary for rapid drainage.

THICKNESS DESIGN:

Design consideration:

- 1) Traffic – volume and loading
- 2) Subgrade support
- 3) Properties of materials in pavement structures

TRAFFIC:

Traffic information is needed to determine the required thicknesses of flexible pavements for any load and volume of traffic; however, individual estimates of traffic and individual designs are not practicable for each and every job although they may be necessary for certain specific projects. Truck or heavy equipment loading on the pavement structure is the principal factor affecting the design.

Traffic Class 3 (Light)—Up to 50 cars per day.

1. Residential driveways.
2. School areas and playgrounds.
3. Parking lots, 50 stalls or less.
4. Airports—7,500 lb. maximum gross weight.
5. Seasonal recreational roads.

Traffic Class 5 (Medium)—Up to 15 trucks and 500 cars per day.

1. Residential streets.
2. Parking lots, more than 50 stalls.
3. Airports—15,000 lb. maximum gross weight.
4. County roads.

Traffic Class 7 (Medium-Heavy)—Up to 150 trucks and 3,000 cars per day per lane.

1. Collector streets.
2. Industrial lots, truck stalls.
3. Bus driveways and loading zones.
4. Airports—30,000 lb. maximum gross weight.
5. County roads.

Traffic Class 9 (Heavy)—Up to 1,200 trucks and 5,000 cars per day per lane.

1. Major arterial streets.
2. Local business streets.
3. Local industrial streets.
4. Major service drives or entrances.
5. Airports—60,000 lb. maximum gross weight.
6. County roads.

Traffic Class 11 (Very Heavy)—Unlimited trucks and cars.

1. Expressways and freeways.
2. Airports—over 60,000 lb. maximum gross weight.

SUBGRADE SUPPORT OR SOIL CLASSIFICATION:

For the designs recommended in this manual all soils are divided into three (3) classes: Excellent (E), Good (G) and Poor (P).

California Bearing Ratio (CBR) design values are assigned to the different subgrade classes.

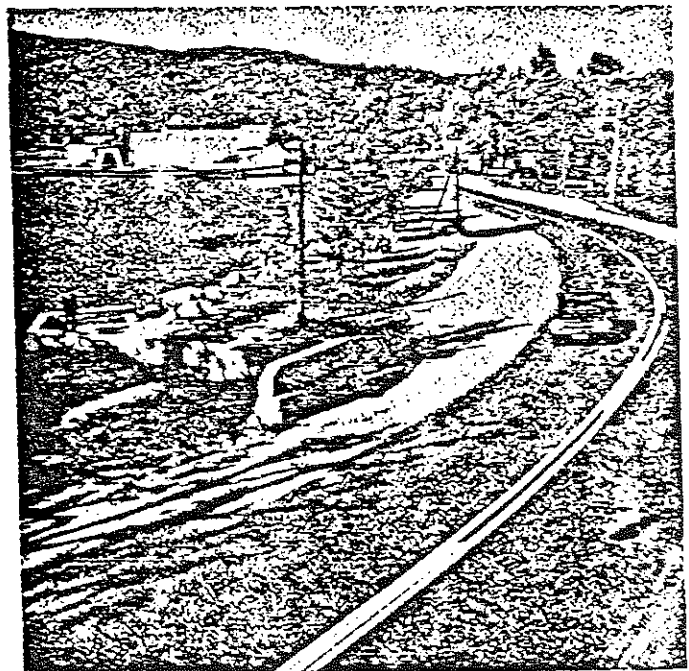
Excellent subgrade soils retain a substantial amount of their load-supporting capacity when wet. Included are the clean sands, sand-gravels and those free of detrimental amounts of plastic materials. Excellent subgrade soils are relatively unaffected by moisture or frost and contain less than 10% passing the No. 200 mesh sieve. An excellent classification would have a CBR value of 10 or more.

Good subgrade soils are those which retain a moderate degree of firmness under adverse moisture conditions. Included are such soils as loams, silty sands and sand gravels containing moderate amounts of clays and fine silts. A good classification will have a CBR value of 6 to 10.

Poor subgrade soils are those which become quite soft and plastic when wet. Included are those soils having appreciable amounts of clay and fine silt (50 percent or more passing 200 mesh sieve). The coarse silts and sandy loams also may exhibit poor bearing properties in areas where deep frost penetration into the subgrade is encountered for any appreciable periods of time. This is also true where the water table rises close to the surface during certain periods of the year. A poor classification will have a CBR value of 3 to 6.

VERY IMPORTANT:

The recommended method to determine a soil classification is the CBR method. It is realized that this is comparatively expensive, especially for small jobs. For this reason other soil classifications may be used. However, if there is any doubt, a reputable laboratory should be contacted.



**TABLE 1
THICKNESS CHART**

Design Criteria		Thickness in Inches		
Traffic Class	Subgrade Class	Hot Mix* Asphalt Base	Surface Course	Total
3	E	3.0	1.0	4.0
	G	3.5	1.5	5.0
	P	5.0	1.5	6.5
5	E	4.0	1.0	5.0
	G	5.0	1.5	6.5
	P	6.5	1.5	8.0
7	E	4.5	1.5	6.0
	G	6.5	1.5	8.0
	P	8.5	2.5	11.0
9	E	5.5	1.5	7.0
	G	7.0	2.5	9.5
	P	11.5	3.0	14.5
11	Requires Special Design			

Notes:

1. A minimum of four (4) inches of hot mix asphalt base may be required for best construction practices.
2. When estimating tons of mix required, use 110 lb/sy for each inch of wearing course, and 105 lb/sy for each inch of HMAB.
3. The higher the crushed content the more stable the mix. When using 100% crushed aggregate (such as slag, crushed gravel or limestone) to make hot mix asphalt base, decrease base thickness by 10%.
4. When using sand to make hot mix asphalt base, increase the base and surface thicknesses by 20%.

* Hot Mix Asphalt Base is designated Bituminous Base Course 3.05, by the Michigan Department of State Highways and Transportation.

THICKNESS DESIGN FORMULA:

From the AASHO (Note 1) Road Test Data it is possible to make direct comparisons of thickness designs by comparing these thicknesses to the AASHO Thickness Index.

The AASHO Thickness Index is a number applied to each individual total thickness design and is computed by using the following formula:

$$D = a_1 D_1 + a_2 D_2 + a_3 D_3$$

D = Minimum AASHO Thickness Index

D₁ = Thickness of Surface

D₂ = Thickness of Base

D₃ = Thickness of Subbase (Note 2)

a₁ = Coefficient of Surface

a₂ = Coefficient of Base

a₃ = Coefficient of Subbase

Thickness Coefficients

Hot mix asphalt surface = 0.42

Hot mix asphalt base = 0.32 (Note 3)

Granular subbase = 0.10

The equivalency factors in the above formula are used in establishing the AASHO thickness index for the designs in Table I. It is not indicated that each of these materials are required, but the thickness of the materials used must equal or exceed the minimum required in the Index formula.

Suggested minimum AASHO Thickness Index:		
Traffic Class	Subgrade Class	Minimum AASHO Thickness Index
3	E	1.40
	G	1.70
	P	2.20
5	E	1.70
	G	2.20
	P	2.70
7	E	2.10
	G	2.70
	P	3.60
9	E	2.40
	G	3.20
	P	4.50

Notes:

1. AASHO—American Association of State Highway Officials.
2. A subbase is not recommended when using a Hot Mix Asphalt Base except under extremely adverse subgrade conditions. When a subbase is used, edge drains or underdrains may be required.
3. The coefficient 0.32 for hot mix asphalt base is used for the first six (6) inches of base. When the base thickness exceeds 6", the coefficient is reduced to 0.24 for the additional thickness.

SPECIFICATION

High Stability Steel Base

MIX DESIGN CRITERIA -

Minimum Marshall Stability	2800
Minimum Voids in Mineral Aggregate	14
Air Voids	3 - 8
Flow	8 - 18
Percent Bitumen	4.5

AGGREGATE -

Shall meet AASHTO M283-81

Gradation -

SIEVE SIZE	PERCENT PASSING	TOLERANCE *
3/4	100	-2
3/8	70 - 90	±6
4	45 - 65	±6
8	40 - 60	±6
30	20 - 40	±6
200	3 - 8	±2

Percent minimum crush content 90

* Tolerance from proposed grading

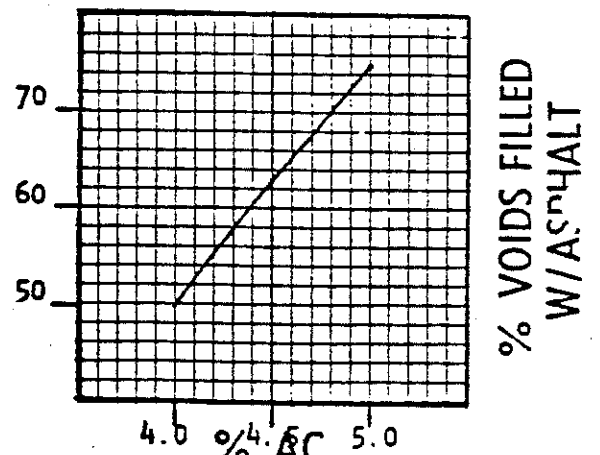
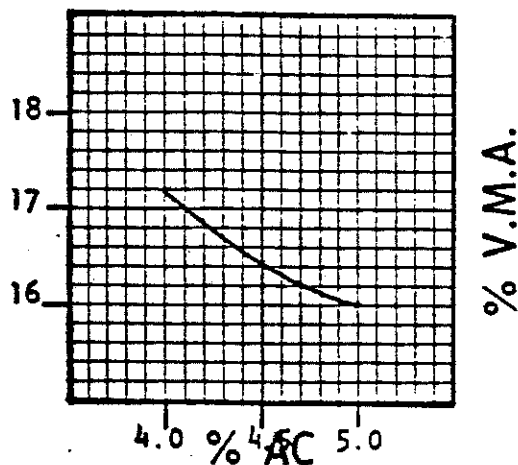
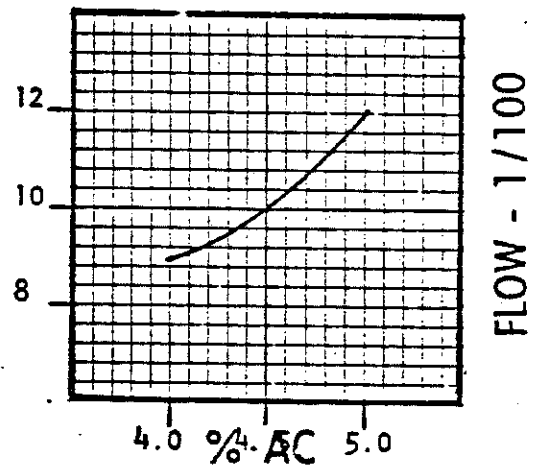
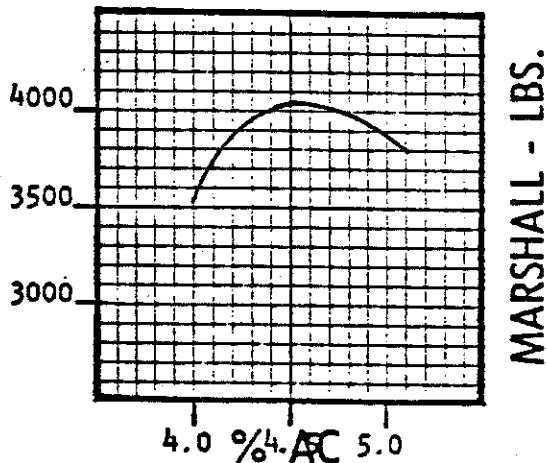
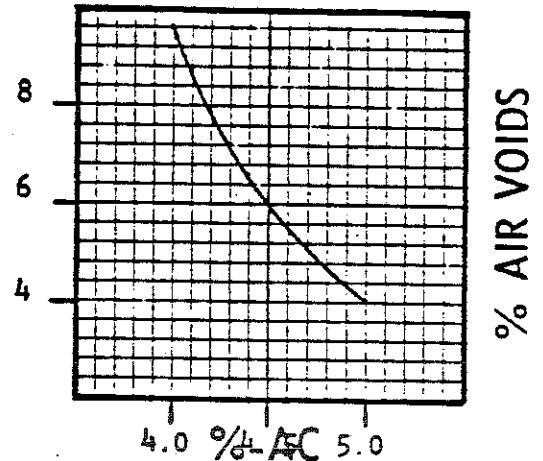
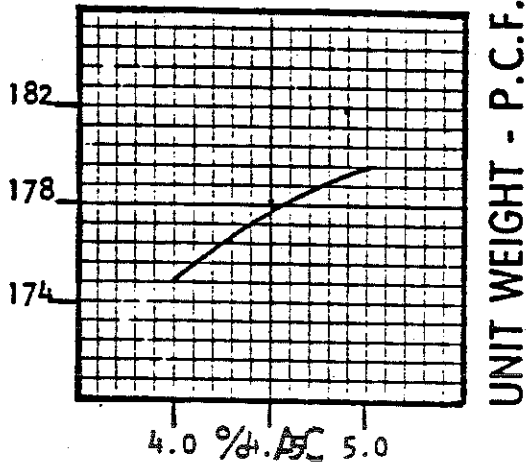
This material shall be produced in accordance with AASHTO - M156-82

APCO

27575 WIXOM ROAD
NOVI, MICH. 48050

HIGH STABILITY
MIX TYPE: STEEL BASE
PROJECT: _____
COMP. BLOW: 50

PLANT NO. 5A
DESIGN BY: T. J. P.
DATE: January 1984



SPECIFICATION

High Stability Steel Wearing

MIX DESIGN CRITERIA -

Minimum Marshall Stability	2800
Minimum Voids in Mineral Aggregate	15.5
Air Voids	3 - 5
Flow	8 - 18
Percent Bitumen	5.8

AGGREGATE - STEEL SLAG -

Shall Meet AASHTO M283-81

Gradation -

SIEVE SIZE	PERCENT PASSING	TOLERANCE *
1/2	100	-2
3/8	90 - 100	±6
4	70 - 85	±6
8	50 - 65	±6
30	25 - 40	±6
200	4 - 8	±1.5

Percent minimum crush content 95

* Tolerance from proposed grading

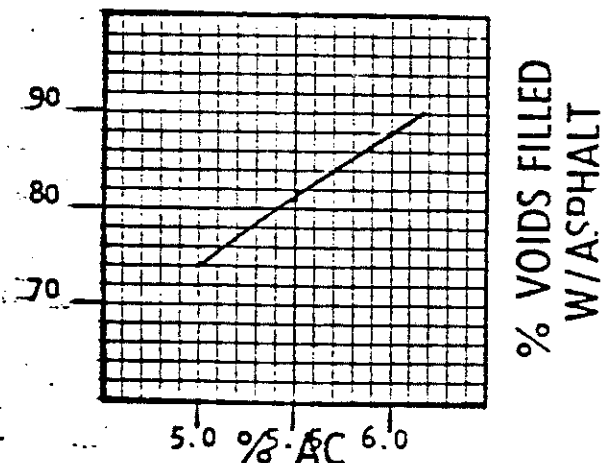
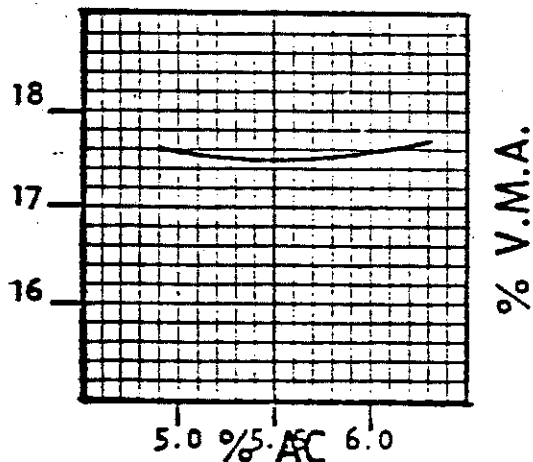
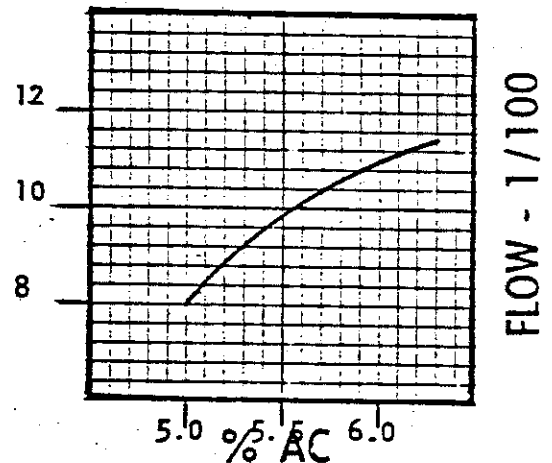
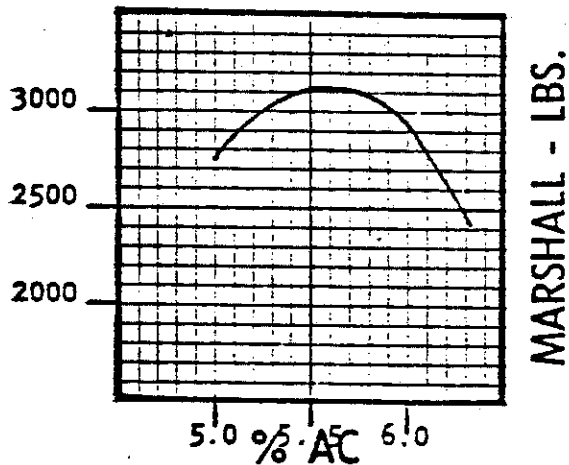
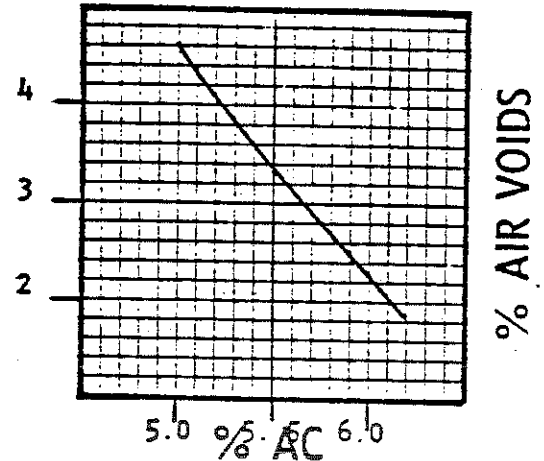
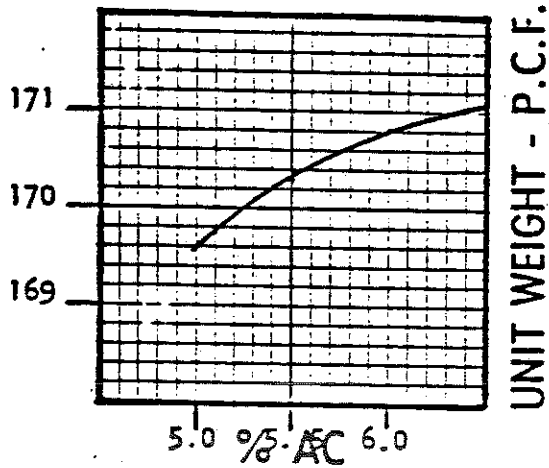
This material shall be produced in accordance with AASHTO - M156-82

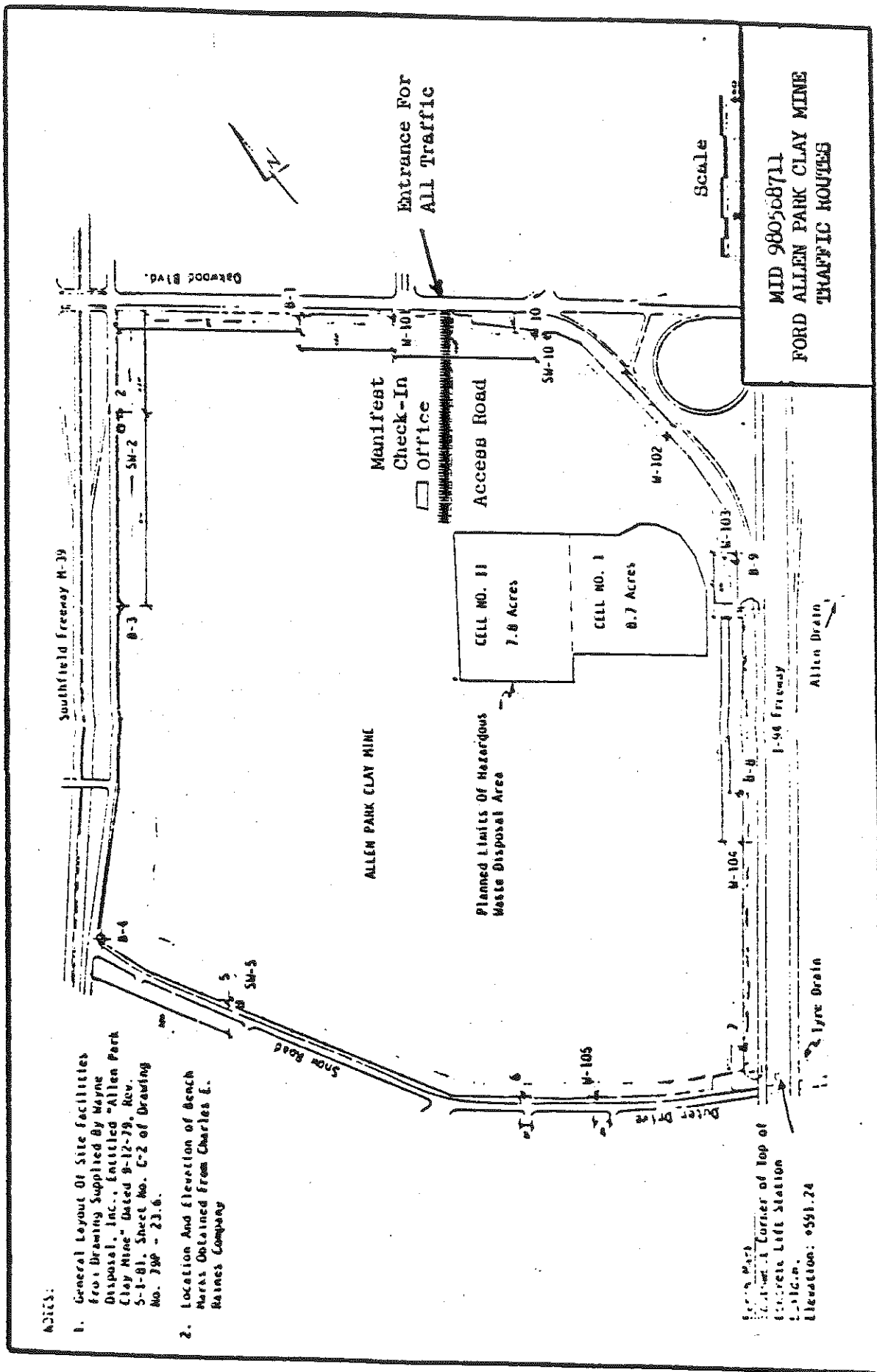
APCO

27575 WIXOM ROAD
NOVI, MICH. 48050

HIGH STABILITY
MIX TYPE: STEEL TOP
PROJECT: _____
COMP. BLOW: 50

PLANT NO. 5A
DESIGN BY: T.J.P.
DATE: January 1984





Traffic Information 40 CFR 270.14(b)(10) (Cont'd)

Trucks disposing of hazardous waste turn left at the manifest trailer and enter the waste management area. Average traffic volumes for the years 1981-1983 are as follows:

1983	946 Yds. ³ ÷ 5 Yds. ³ /truck = 3.6 trucks/week
1982	2,142 Yds. ³ ÷ 10 Yds. ³ /truck = 4.1 trucks/week
1981	32,452 Yds. ³ ÷ 20 Yds. ³ /truck = 31.1 trucks/week

Traffic volume for Cell II based on the projected maximum waste disposal rates is calculated as follows:

K061	19,074 tons ÷ 35 tons/truck = 10.5 trucks/week
K087	520 tons ÷ 5 tons/truck = 2.0 trucks/week
K087	4,750 tons ÷ 20 tons/truck = 17.1 trucks/week
F006	20,000 tons ÷ 10 tons/truck = 38.5 trucks/week
D006	20,000 tons ÷ 35 tons/truck = 11.0 trucks/week
D007	20,000 tons ÷ 35 tons/truck = 11.0 trucks/week
D008	20,000 tons ÷ 35 tons/truck = 11.0 trucks/week
Non-Hazardous	21,000 tons ÷ 35 tons/truck = <u>11.5 trucks/week</u>
Total	112.6 trucks/week

Ford Allen Park Clay Mine

MID 980568711

Section C Waste Characteristics

C-1 Chemical and Physical Analyses 40 CFR 270.14b(2)

Waste types to be disposed of at the facility are:

- . (K061) Electric Furnace Emission Control Dust
- . (K087) Decanter Tank Tar Sludge from Coking Operations
- . (F006) Wastewater Treatment Sludges from Electroplating Operations
- . (D006) EP Toxic - Cadmium
- . (D007) EP Toxic - Chromium
- . (D008) EP Toxic - Lead

(K061) Electric Furnace Emission Control Dust

K061 is inorganic mineral matter generally composed of iron, calcium and manganese oxides in particulate form. Refer to Attachment 6 for the EPA Listing Document which describes the waste, the hazard characteristics, the basis for the hazard designation and provides a generalized oxide analysis of the waste. Chemical analysis, density, and EP toxicity results of a representative sample taken from the Rouge Steel Company waste stream is provided on Attachment 9. K061 is hazardous due to the leachate concentrations of lead, chromium, and cadmium which are contained in the waste. The relatively lower hazard to the environment posed by disposal of electric furnace emission control dust is recognized by EPA in the July 26, 1982, Federal Register, which indicates that facilities

(K061) Electric Furnace Emission Control Dust (Cont'd)

disposing of K061 may not be required to meet all of the standards of other hazardous waste landfills. Pertinent portions of FR 47 No. 143 follow:

Federal Register / Vol. 47, No. 143 / Monday, July 26, 1982 / Rules and Regulations

32281

2. Monofills and Neutralization Surface Impoundments. The Agency believes that two types of waste management units covered by today's Part 264 permitting standards should not be subject to the full set of standards promulgated today. These are monofills and neutralization surface impoundments. EPA intends to propose separate standards for these units.

Monofills are landfills, surface impoundments, or waste piles used to treat, store or dispose of one or more of a small group of inorganic wastes. This group includes wastes that are hazardous solely because they exhibit the characteristic of EP toxicity (defined in § 261.24). EP toxicity is a characteristic that indicates the likelihood that certain metals and other constituents could be leached by an acidic leaching medium in significant

concentrations. This group is further limited to specific wastes that the Agency formally finds would not leach significant concentrations of these constituents in the absence of an acid leaching medium. At present, the Agency expects that the following wastes may meet the above criteria and thus would be eligible for inclusion in a future regulation concerning monofills:

1. Incinerator ash;
2. Residues from foundry furnace emissions controls;
3. Metal casting molding sand;
4. Cement kiln dust and clinker;
5. Hydroxide and carbonate sludges resulting from the treatment of plating bath waste;
6. Residues from titanium dioxide production;
7. Oven residue from the production of chrome and oxide green pigments (listed in § 261.32 as waste K008); and
8. Emission control dust or sludge from the production of steel (including the waste listed in § 261.32 as K081).

Under management conditions that preclude contact between the above wastes and acids, EPA believes that there may be an extremely low likelihood that significant concentrations of hazardous constituents could leach into nearby ground waters. In essence, although these wastes have the potential to cause substantial harm if mismanaged (since they exhibit the characteristic of EP toxicity), they may be managed in a way that makes it very unlikely for this harm to occur. Therefore, EPA believes that it may be unnecessary to require monofills that prevent waste-acid contact to comply with the full Part 264 standards.

(K087) Decanter Tank Tar Sludge From Coking Operations

K087 is generally composed of elemental carbon (97%) and condensed tar materials (3%). Refer to Attachment 5 for the EPA Listing Document which describes the waste, the hazard characteristics, the basis for the hazardous designation and the relative toxicity of the waste. The EP toxicity results and the phenol and naphthalene content of the Rouge Steel Company waste stream is provided in Attachment 9. As there are no decomposition products of the waste stream, no gas will be generated. To facilitate material handling, fine coke screenings (coke breeze) are placed in the truck bed. The coke is made of coal which has been fused at high temperatures such that the volatiles are driven off. The K087 is loaded on top of the coke. Upon tipping, the complete load slides out cleanly, and the load has an increased firmness.

(F006) Wastewater Treatment Sludges From Electroplating Operations

F006 is a metal hydroxide sludge from electroplating (phosphating) wastewater pretreatment operations. Density is approximately 90 lbs./ft.³ Color is usually blue-green, and there is no characteristic odor. The solids content is usually greater than 40%. pH is usually greater than 6.0 but less than 9.0. The basis for hazardous designation is the heavy metal and/or phosphate content. The source of these wastes will be from Ford Motor Company wastewater pre-treatment facilities which began operating on July 1, 1984. Waste analyses will not be available until after that date. Typical range of hydroxide sludge constituents based on 6 samples from various Ford plants are provided on Attachment 9.

(FO06) Wastewater Treatment Sludges From Electroplating Operations (Cont'd)

These sludges will be generated from the following Ford facilities:

- . Brownstown Parts Redistribution Center
- . Dearborn Assembly/Frame Plant
- . Rawsonville
- . Saline
- . Sheldon Road
- . Wayne Assembly/Michigan Truck
- . Ypsilanti

(DO06) EP Toxic - Cadmium

DO06 is a waste that exhibits the characteristic of EP toxicity. The particular source of waste might include Emission Control Dust from the Basic Oxygen Furnace (BOF) in the steelmaking operations. This waste is presently neither a hazardous waste based on listing or characteristic. Such dust could have the cadmium content due to the increased usage of galvanized scrap into the hot metal charge. The dust would otherwise be very similar to the K061 in chemical and physical properties. The analysis of the BOF dust is provided on Attachment 9. Wastewater sludge from the steel galvanizing process or continuous caster (two process changes scheduled in the future) might produce this waste in a metal hydroxide form. Analyses will be obtained prior to waste acceptance.

(D007) EP Toxic - Chromium

D006 is a waste that exhibits the characteristic of EP toxicity. The particular waste source might include BOF dust from the steelmaking operations. This waste is presently neither a hazardous waste based on listing or characteristic. The analysis of BOF dust is provided on Attachment 9. Wastewater sludge from the steel galvanizing process or continuous caster (two process changes scheduled in the future) might produce this waste in a metal hydroxide form. Analyses will be obtained prior to waste acceptance.

(D008) EP Toxic - Lead

D008 is a waste that exhibits the characteristic of EP toxicity. The particular waste source might include BOF dust from the steelmaking operations. This waste is presently neither a hazardous waste based on listing or characteristic. The analysis of BOF dust is provided on Attachment 9. Wastewater sludge from the steel galvanizing process or continuous caster (two process changes scheduled in the future) might produce this waste in a metal hydroxide form. Analyses will be obtained prior to waste acceptance.

C-1a through C-1f not applicable.

C-2 Waste Analysis Plan 40 CFR 270.14(b)(3), 264.12(b)(c)

The facility Waste Analysis Plan is provided in Attachment 10.

Ford Motor Company Allen Park Clay MineMID 980568711Chemical AnalysesF006 - Wastewater Treatment Sludge from Electroplating Operations

Typical range of hydroxide sludge constituents based on 6 samples from various Ford plants (Norfolk, Atlanta, Chicago, Kansas City)

	Range (ppm)	
	Low	High
As	<.0008	<.25
Ba	<.10	<.68
Cd	<.002	<.005
Cr (Total)	<.002	<.25
Pb	<.02	<.25
Hg	<.0002	<.05
Se	<.002	<.05
Ag	<.002	<.25
Zn	18.0	33.0
Ni	18.0	45.0
Cu	<.002	<.002

It is assumed that these results are typical of wastes being generated at the previously identified new WWTP's. Analyses will be provided before acceptance of this waste type at the permitted site.



CENTRAL LABORATORY SERVICES

LABORATORY INVESTIGATION REPORT

MANUFACTURING ENGINEERING
ENVIRONMENTAL CONTROL
STEEL DIVISION

Attachment 9

Partial Supplement

NUMBER 105574

JAN 28 1 14 PM '82

January 28, 1982

TO: John Schultz

SUBJECT: Electric furnace flue dust

OBJECT: Determine E. P. Toxicity metals in Electric Furnace Flue Dust for information

CONCLUSION: Reported as observed in flue dust. The following E. P. Toxicity Metals are above required limit: Cadmium, Lead, Zinc.

TEST DATA:

<u>Element</u>	<u>ppm</u>	<u>E. P. Toxicity Limit</u>	<u>Method</u>
Arsenic	(1)	5.0	
Barium	14.1	100.0	EPA 79, M 208.1
Cadmium	3.4*	1.0	EPA 79, M 213.1
Copper	2.8	100.0	Flame Atomic Absorption
Chromium	0.2	5.0	EPA 79, M 218.1
Lead	69.5*	5.0	EPA 79, M 239.1
Mercury	(1)	0.2	
Selenium	(1)	1.0	
Silver	0.3	5.0	EPA 79, M 272.1
Zinc	1,300* (.13%)*	500.0	Electroplating

Note:

(*) Asterisk indicates element is over E. P. Toxicity Limit.

(1) Results to follow in near future.

Cathy Holda
Metallurgy Department

CH - BAS / el

NO
Oct 81 16011-2



CENTRAL LABORATORY SERVICES

LABORATORY INVESTIGATION REPORT

Attachment 9

Partial

NUMBER 105574-4

January 26, 1982

TO: John Schultz

SUBJECT: Electric Furnace Flue Dust
From Steel DivisionOBJECT: To determine the Density and EP Toxicity (cyanide) of the Electric
Furnace Flue Dust for information.

TEST DATA:

Sample I.D.	Cyanide (mg/L) EPA 79: M335.2	Density (g/ml) ASTM B212-76
Electric Furnace Flue Dust	0.21	1.53

By B. A. Schigelone 1-27-82
B. A. Schigelone
(BN 981, pg 54)

Concur:

J. A. Galloway
J. A. Galloway, Section Supervisor
Environmental Section
Chemistry Department

$$\text{Density } (1.53 \text{ g/ml}) \left(\frac{1 \text{ ml}}{0.06102 \text{ in}^3} \right) \left(\frac{1 \#}{453.6 \text{ g}} \right) \left(\frac{1728 \text{ in}^3}{\text{ft}^3} \right) \\ = 95.5 \#/\text{ft}^3$$

JAN 30 8 22 AM '82

BAS - el

MANUFACTURING ENGINEERING
& ENVIRONMENTAL CONTROL
STEEL DIVISIONITC
Oct 81 16011-2

Electric Furnace Flue Dust (K061)

A. Sample Taken:
Lab No. 004680

1. E.P. Toxicity per U.S. EPA SW-846, 1980

<u>Element</u>	<u>Results, ppm</u>	<u>Method of Analysis</u>
Arsenic	0.6	EPA 600/4-79-020
Barium	< 0.8	"
Cadmium	45.0	"
Chromium	1.6	"
Lead	340	"
Mercury	0.0015	Perkin-Elmer 303-3119
Selenium	2.0	I.C.P.
Silver	0.8	EPA 600/4-79-020

2. Chemical Analysis of Electric Furnace Flue Dust

<u>Element</u>	<u>Results (mg/kg)</u>	<u>Method of Analysis</u>
Arsenic	50	ASTM E 663
Barium	< 0.8	"
Cadmium	95.0	"
Chromium	500	"
Lead	4,500	"
Mercury	< 0.3	I.C.P.
Selenium	2.0	I.C.P.
Silver	6.0	ASTM E 663
Manganese	39,000	"
Zinc	150,000	"
Phosphorus	450	Molybdate
Sulfur	3,600	lr 32-Leco
Calcium	61,000	ASTM E 663
Magnesium	11,000	"
Aluminum	2,400	"
Silicon	15,000	Na ₂ CO ₃ Fusion
Potassium	5,900	ASTM E 663
Sodium	5,200	"
Fluorine	26.2	Ion Chromatograph
Total Iron	350,000	ASTM E 663
Dissolved Iron	800	"
Cyanide	0.1	EPA 79, M3352
Phenol	0.960	EPA 79, M420.1
Carbon	4,700	Leco Wr-12



CENTRAL LABORATORY SERVICES
LABORATORY INVESTIGATION REPORT

FN 4716

Attachment 9

NUMBER 221453

May 9, 1983

TO: G.E. Waggoner

SUBJECT: EAF Dust #2
Specification: State of Michigan Regulation
R 299.6315, Table 303

OBJECT: Determine E.P.A. toxicity as per SW-846-1980 on extract of submitted EAF dust #2 for conformance to State of Michigan Regulation R 299.6315, Table 303.

CONCLUSION: The concentrations of zinc and lead in the submitted flue dust extract exceeds the maximum allowed concentration specified in State of Michigan Regulation R 299.6315, Table 303.

TEST DATA: Chemical composition, milligrams per liter

		Specification R 299.6315 Table 303
Arsenic	0.3	5.0 max.
Barium	0.65	100.0 max.
Cadmium	0.5	1.0 max.
Chromium	<0.1	5.0 max.
Copper	0.3	100.0 max.
Cyanide	<0.02	20.0 max.
Lead	10.3 *	5.0 max.
Mercury	<0.1	0.2 max.
Nickel	0.2	none given
Selenium	0.6	1.0 max.
Silver	<0.1	5.0 max.
Zinc	1220 *	500.0 max.

* Not to specification.

Test Methods: E.P.A. Toxicity test SW-846-1980,
Inductively Coupled Plasma Emission
Spectroscopy

<= less than

by David Spaight
David Spaight, Engineer
Metallurgy Department

DS/pk

JDP-5-10-83

CLOWPRO RESEARCH SERVICES
Water Management Division
Clow Corporation

Pontiac, MI 48108

March 16, 1982

Attachment 9

13 334 747

12 9:41

PROCES.

Ford Motor Company
SS300
Parklane Towers, Suite 623 W
One Parklane Blvd.
Dearborn, MI 48126
Attn: Ed Chraszcz

Samples received 3-3-82 Samples collected 2-26-82 PW# 771029

Hydro number: 53885

Client identification: SS300# 202260271

	<u>Decanter Tank-</u> <u>Tar Sludge as</u> <u>rec'd</u>	<u>Decanter Tank- tar</u> <u>Sludge leachate</u> <u>performed by Ford</u>
phenol, mg/kg	110	_____
naphthalene, mg/kg	1600	_____
Arsenic, As, mg/l	_____	<0.005
Barium, Ba, mg/l	_____	<1
Cadmium, Cd, mg/l	_____	0.01
Total Chromium, Cr., mg/l	_____	<0.02
Lead, Pb, mg/l	_____	<0.05
Mercury, Hg, mg/l	_____	<0.0005
Selenium, Se, mg/l	_____	<0.005
Silver, Ag, mg/l	_____	<0.02
Copper, Cu, mg/l	_____	0.05
Nickel, Ni, mg/l	_____	0.03
Zinc, Zn, mg/l	_____	0.11

Linda Deans
General Laboratory Manager



CENTRAL LABORATORY SERVICES

LABORATORY INVESTIGATION REPORT

Attachment 9

NUMBER 105723

November 16, 1981

TO: John F. Schultz

SUBJECT: Decanter Tank Tar Sludge
Supplier: Steel Division

OBJECT: To determine density and % solids as well as phenol and naphthalene contamination of Decanter Tank Tar Sludge for information.

TEST DATA:	Results	Specification	Analyst
Density	1.21 g/ml	ASTM D891	BAS
% Solids (% Non-Volatiles)	80.00 %	FLTM BI 2-1	BAS
Phenol	2137.23 ⁴ mg/L	EPA79 M420.1	BAS/JF
Napthalene	3.307 g/kg	HPLC	DPL
Cyanide	17.39 mg/L	EPA79 M335.2	BAS

Concur:

J. A. Galloway
J.A. Galloway, Section Supervisor
Environmental Section
Chemistry Department

by

B. A. Schigelone 11-16-81
B. A. Schigelone

BS - el

10
11 81 16011-2

Dome Oven Tar Decanter Sludge (K087)

Sample Taken: 8-28-80
Lab No. C05092

1. E.P. Toxicity per U.S. EPA SW-846, 1980

<u>Element</u>	<u>Results, ppm</u>	<u>Method of Analysis</u>
Arsenic	< 0.1	EPA 600/4-79-020
Barium	< 0.8	"
Cadmium	< 0.005	"
Chromium	< 0.1	"
Lead	0.2	"
Mercury	0.0001	Perkin-Elmer 303-3119
Selenium	< 0.25	EPA 600/4-79-020
Silver	< 0.1	"

2. Ignitability per U.S. EPA SW-846, 1980, Section 4.0

Flash Point > 60°C
ASTM D 93

3. Reactivity per U.S. EPA SW-846, 1980, Section 6.0

Total Cyanide 10.65 ppm
EPA 79, M3352



CENTRAL LABORATORY SERVICES

Attachment 9

GENERAL SERVICES

LABORATORY INVESTIGATION REPORT

NUMBER 005011

TEST DATA: (Continued)

Page 2

2. Chemical Analysis of B.O.F. Flue Dust, Coarse

<u>Element</u>	<u>Results, ppm (mg/kg)</u>	<u>Method</u>
Arsenic	32	ASTM E 663
Barium	<0.8	ASTM E 663
Cadmium	10	ASTM E 663
Chromium	100	ASTM E 663
Lead	<0.2	ASTM E 663
Mercury	<0.5	I. C. P.
Selenium	20	ASTM E 663
Silver	<0.1	ASTM E 663
Manganese	5,500	ASTM E 663
Zinc	3,800	ASTM E 663
Phosphorus	120	Molybdate
Sulfur	200	Ir 32 - Leco
Calcium	80,000	ASTM E 663
Magnesium	19,000	ASTM E 663
Aluminum	1,000	ASTM E 663
Silicon	19,000	Na ₂ CO ₃ Fusion
Potassium	180	ASTM E 663
Sodium	330	ASTM E 663
Fluorine	13.55	Ion Chromatograph
Total Iron	480,000	ASTM E 663
Dissolved Iron	<0.2	ASTM E 663
Cyanide	<0.1	E.P.A. 79, 163352
Phenol	<0.050	E.P.A. 79, 1620.1
Carbon	4,000	LECO Wr-12

Concur:

J. A. Galloway
J. A. Galloway, Section Supervisor
Environmental Section
Chemistry Department

By:

K. G. Reaume
K. G. Reaume, C. Holda

Concur:

D. Craig
D. Craig, Supervisor
Metallurgy Department

RJR:CH/em





CENTRAL LABORATORY SERVICES

GENERAL SERVICES

LABORATORY INVESTIGATION REPORT

Attachment 9

NUMBER 004302

TO: Chris Porter

October 20, 1980

SUBJECT: B. O. F. ESP. Flue Dust

OBJECT: Test per request.

TEST DATA:

1. E. P. Toxicity per U. S. E. P. A. SW-846, 1980

<u>Element</u>	<u>Results, ppm</u>	<u>Specification Limits, ppm</u>	<u>Method of Analysis</u>
Arsenic	0.13	5	EPA 600/4-79-020
Barium	0.68	100	EPA 600/4-79-020
Cadmium	0.13	1	EPA 600/4-79-020
Chromium	<0.10	5	EPA 600/4-79-020
Lead	2.68	5	EPA 600/4-79-020
Mercury	Not determined	0.2	
Selenium	<0.25	1	EPA 600/4-79-020
Silver	<0.10	5	EPA 600/4-79-020

* A supplemental report will follow with Mercury values tested to EPA 600/4-79-020.

Continued on page 2)





CENTRAL LABORATORY SERVICES

Attachment 9

GENERAL SERVICES

LABORATORY INVESTIGATION REPORT

NUMBER 004302

TEST DATA: (Continued)

Page 2

2. Chemical Analysis of B. O. F. Flue Dust

<u>Element</u>	<u>Results, ppm (mg/kg)</u>	<u>Method</u>
Arsenic	42	ASTM E 663
Barium	<0.8	ASTM E 663
Cadmium	50	ASTM E 663
Chromium	130	ASTM E 663
Lead	3,000	ASTM E 663
Mercury	<0.5	I. C. P.
Selenium	<0.25	ASTM E 663
Silver	<0.10	ASTM E 663
Manganese	10,000	ASTM E 663
Zinc	22,000	ASTM E 663
Phosphorus	190	Molybdate
Sulfur	1,600	Ir. 32 - Leco
Calcium	2,000	ASTM E 663
Magnesium	9,600	ASTM E 663
Aluminum	<1.7	ASTM E 663
Silicon	8,000	Na ₂ CO ₃ Fusion
Potassium	5,000	ASTM E 663
Sodium	2,300	ASTM E 663
Fluorine	23.09	Ion Chromatograph
Total Iron	560,000	ASTM E 663
Dissolved Iron	120	ASTM E 663
Cyanide	0.20	E.P.A. 79, M3352
Phenol	<50 ppb	E.P.A. 79, M320.1
Carbon	7,400	LECO Wr-12

Concur: J. A. Galloway
J. A. Galloway, Section Supervisor
Environmental Section
Chemistry Department

By K. G. Reaume CHH
K. G. Reaume, C. Holda

Concur: D. Craig
D. Craig, Supervisor
Metallurgy Department

RGR:CH/em



CENTRAL LABORATORY SERVICES

GENERAL SERVICES

LABORATORY INVESTIGATION REPORT

MINING ENGINEERING AND
DEVELOPMENT DEPT
STEEL DIVISION

Attachment 9

NUMBER 101948

MAY 11 8 35 AM '81

May 7, 1981

TO:

C.H. Porter

SUBJECT:

Leachate of BOF Flue Dust

OBJECT:

Determine E.P. toxicity metals in leachate, for information.

TEST DATA:

Chemical composition

	(ppm)	(Limit ppm)
Arsenic	0.02	5.0
Barium	<0.04	100.0
Cadmium	0.03	1.0
Chromium (total)	<0.05	5.0
Lead	1.7	5.0
Mercury	++	0.2
Selenium	++	1.0
Silver	<0.01	5.0

++ Supplement report to follow.

<= less than

by

*Cathy Holda*Cathy Holda
Metallurgy Department

CH/pk



CENTRAL LABORATORY SERVICES

GENERAL SERVICES

LABORATORY INVESTIGATION REPORT

Attachment 9
Supplement

NUMBER 101940

June 2, 1981

TO: C.H. Porter

SUBJECT: Leachate of a B.O.F. Flue Dust

OBJECT: Determine the E.P. toxicity metals, selenium and mercury in the leachate. For information.

TEST DATA: Chemical composition

	<u>ppm</u>	<u>Limit (ppm)</u>
Selenium	<0.01	1.0
Mercury	<0.01	0.2

Analysis of leachate was performed by an outside laboratory.

<= less than

by Cathy Holda
Cathy Holda
Metallurgy Department

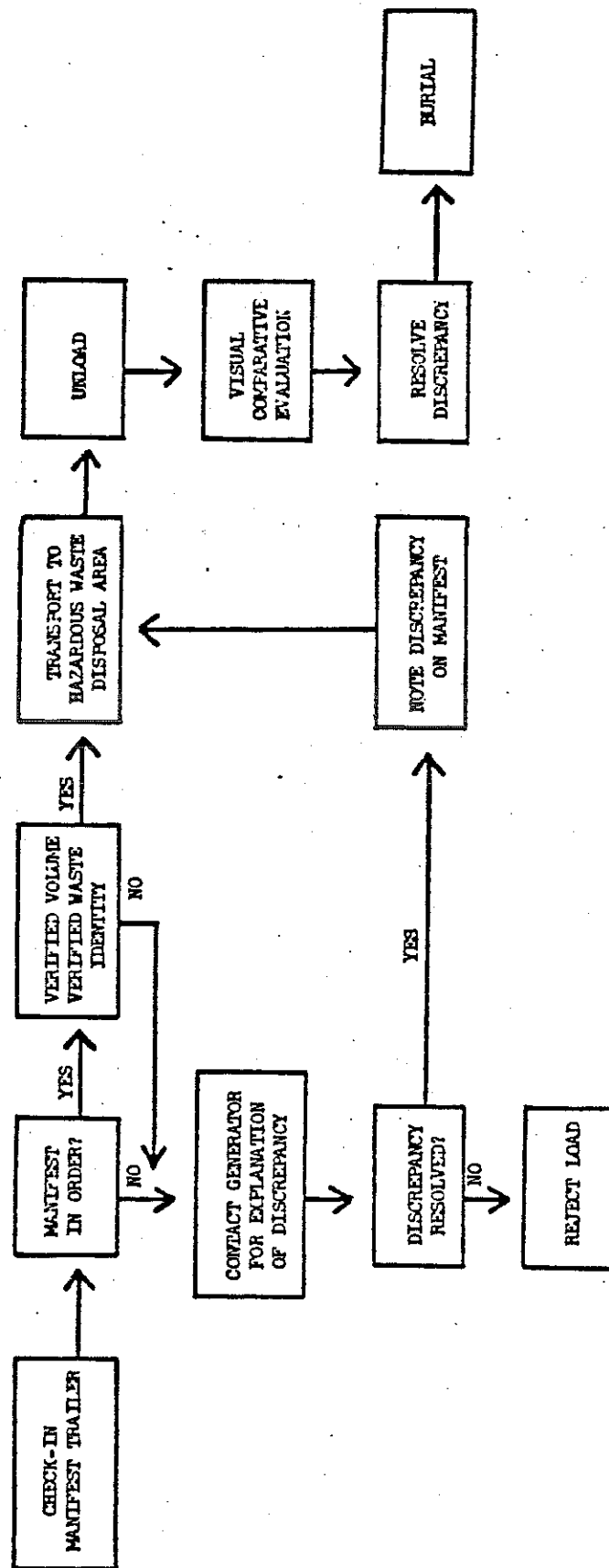
CH/pk

Ford Motor Company Allen Park Clay Mine

MID 980568711

Waste Analysis Plan

The manifest checker has the primary responsibility to determine the identity of each movement of waste at the facility. Samples of the wastes to be handled at the facility will be available for comparative purposes. All wastes are examined by the operating engineer before burial. Manifested volumes are also verified. Also attached is the Process Flow Diagram outlining the operational procedures.



PROCESS FLOW DIAGRAM - FORD MOTOR COMPANY - ALLEN PARK CLAY MINE

Ford Motor Company Allen Park Clay MineMTD 980568711Waste Analysis Plan

Hazardous Waste Name: Electric Arc Furnace Baghouse Dust

EPA I.D. Number: KO61

Line Number on Part A Application: 1

Detailed Analyses: Refer to Attachment 9

Method of Disposal: Landfill

Sample Method: ASTM D346-78 for Crushed/Powdered Materials

Analytical Parameters, Frequency, Rationale, Method:

Chromium, Cadmium, Lead - Analyze yearly, verification of hazardous classification, EP Toxicity (40 CFR 261, Appendix II).

Color - Verify each load, characteristic red, visual comparison.

Particle Size - Verify each load, characteristic particle size (dust), visual comparison.

Density - Analyze yearly, characteristic of waste, ASTM B212-76.

Bearing Strength - Analyze yearly, characteristic of waste, ASTM D-2435, D-2166.

Compatibility - Analyze yearly, assure integrity of leachate collection system and verify that waste mixtures do not generate harmful heat, gas, or explosions, mix materials together and note observations.

Ford Motor Company Allen Park Clay Mine

MTD 980568711

Waste Analysis Plan

Hazardous Waste Name: Decanter Tar from Coking Operations

EPA I.D. Number: K087

Line Number on Part A Application: 2

Detailed Analyses: Refer to Attachment 9

Method of Disposal: Landfill

Sample Method: ASTM D140-70 for extremely viscous liquids

Analytical Parameters, Frequency, Rationale, Method:

Phenol - Analyze yearly, verification of hazardous classification, SW-846 (8040).

Naphthalene - Analyze yearly, verification of hazardous classification, SW-846 (8100).

Color - Verify each load, characteristically black, visual comparison.

Odor - Verify each load, characteristic smell, visual comparison.

Free Liquids - Inspect each load, free liquids not acceptable, visual observation.

Density - Analyze yearly, characteristic of waste, ASTM D-891.

Bearing Strength - Analyze biannually, provision for waste stabilization, ASTM D-2435, D-2166.

Compatibility - Analyze yearly, assure integrity of leachate collection system and verify that waste mixtures do not generate harmful heat, gas, or explosions, mix materials together and note observations.

Ford Allen Park Clay Mine

MID 980568711

Waste Analysis Plan

Hazardous Waste Name: Wastewater Treatment Sludge from Electroplating Operations

EPA I.D. Number: F006

Line Number on Part A
Application: 3

Detailed Analyses: Refer to Attachment 9

Method of Disposal: Landfill

Sample Method: SW 846, Section 1.4

Analytical Parameters,
Frequency, Rationale,
Method:

Color - Verify each load, characteristically blue-green,
visual comparison.

Odor - Verify each load, no characteristic smell, visual
comparison.

Free Liquids - Inspect each load, free liquids not
acceptable, visual observation.

Density - Analyze yearly, characteristic of waste, ASTM
D-891.

Bearing Strength - Analyze biannually, provision for
waste stabilization, ASTM D-2435, D-2166.

Compatibility - Analyze yearly, assure integrity of
leachate collection system, and verify that waste
mixtures do not generate heat, gas, or explosions.
Mix materials, and note observations.

Ford Allen Park Clay MineMID 980568711Waste Analysis Plan

Hazardous Waste Name: . EP Toxic - Cadmium

EPA I.D. Number: D006

Line Number on Part A
Application: 4

Detailed Analyses: Refer to Attachment 9

Method of Disposal: Landfill

Sample Method: SW 846, Section 1.4

Analytical Parameters,
Frequency, Rationale,
Method:

Cadmium - Analyze yearly, verification of hazardous classification, EP toxicity (40 CFR 261, Appendix II).

Color - Verify each load, characteristic color, visual comparison.

Odor - Verify each load, no characteristic smell, visual comparison.

Free Liquids - Inspect each load, free liquids not acceptable, visual observation.

Density - Analyze yearly, characteristic of waste, ASTM D-891.

Bearing Strength - Analyze biannually, provision for waste stabilization, ASTM D-2435, D-2166.

Compatibility - Analyze yearly, assure integrity of leachate collection system, and verify that waste mixtures do not generate heat, gas, or explosions. Mix materials, and note observations.

Ford Allen Park Clay MineMID 980568711Waste Analysis Plan

Hazardous Waste Name: EP Toxic - Chromium

EPA I.D. Number: D007

Line Number on Part A
Application: 4

Detailed Analyses: Refer to Attachment 9

Method of Disposal: Landfill

Sample Method: SW 846, Section 1.4

Analytical Parameters,
Frequency, Rationale,
Method:

Chromium - Analyze yearly, verification of hazardous classification, EP toxicity (40 CFR 261 Appendix II).

Color - Verify each load, characteristically black, visual comparison.

Odor - Verify each load, characteristic smell, visual comparison.

Free Liquids - Inspect each load, free liquids not acceptable, visual observation.

Density - Analyze yearly, characteristic of waste, ASTM D-891.

Bearing Strength - Analyze biannually, provision for waste stabilization, ASTM D-2435, D2166.

Compatibility - Analyze yearly, assure integrity of leachate collection system, and verify that waste mixtures do not generate heat, gas, or explosions. Mix materials, and note observations.

Ford Allen Park Clay MineMID 980568711Waste Analysis Plan

Hazardous Waste Name: EP Toxic - Lead

EPA I.D. Number: D008

Line Number on Part A
Application: 4

Detailed Analyses: Refer to Attachment 9

Method of Disposal: Landfill

Sample Method: SW 846, Section 1.4

Analytical Parameters,
Frequency, Rationale,
Method:

Lead - Analyze yearly, verification of hazardous classification, EP toxicity (40 CFR 261 Appendix II).

Color - Verify each load, characteristically black, visual comparison.

Odor - Verify each load, characteristic smell, visual comparison.

Free Liquids - Inspect each load, free liquids not acceptable, visual observation.

Density - Analyze yearly, characteristic of waste, ASTM D-891.

Bearing Strength - Analyze biannually, provision for waste stabilization, ASTM D-2435, D-2166.

Compatibility - Analyze yearly, assure integrity of leachate collection system, and verify that waste mixtures do not generate heat, gas, or explosions. Mix materials and note observations.

Ford Motor Company Allen Park Clay Mine

MID 980568711

Section D Process Information

D-6a List of Wastes 40 CFR 270.21(a)

K061, K087, F006, D006, D007, D008

D-6b Exemption Request 40 CFR 270.21(b)(1)

No exemption is requested.

D-6c Liner Engineering Report 40 CFR 270.21(b)(1)

The site hydrology is governed by the last glacial period in which the Huron-Erie ice lobe occupied southeast Michigan. When the ice lobe retreated, a uniform clay deposit was left in its place that is generally 80-120 feet thick and has become an effective aquiclude since the lake recession.

The confined aquifer is located approximately 70 feet below the existing grade at the Allen Park site and varies in thickness from one to six feet. It exerts an upward hydrostatic pressure on the clay aquiclude equivalent to 80 feet of head. This hydraulic gradient in the upward direction is a counteracting force against those of leachate migration (drag coupling effect and chemico-osmotic diffusion). Under these conditions, there is no potential for migration of liquid from the regulated unit to the uppermost aquifer during the active life of the regulated unit and the post closure care period.

D-6c Liner Engineering Report 40 CFR 270.21(b)(1) (Cont'd)

The liner system is constructed out of an insitu uniform clay stratum and is coupled with an artesian aquifer which exerts an upward hydraulic gradient to the surface grade. Refer to the groundwater waiver demonstration provided in Attachment 15 for the engineering and hydrogeological documentation concerning this liner system. Included in this demonstration is a study on potential leachate migration at the site. This liner system is in satisfaction of 40 CFR 264.301(a) requirements. Refer to the Engineering Drawings for additional liner detail (Attachment 14).

D-6c(1) Liner Description 40 CFR 270.21(b)(1)

The liner system is constructed of four components as shown on Attachment 11 and described below.

1. Artesian Aquifer

The artesian aquifer, which lies forty feet below the bottom of the cell, has a hydraulic gradient which extends above the surface grade. The hydrostatic pressure exerted upon the overlying clay deposit maintains the saturation of the clay and negates downward migration of fluids from the surface.

The water in the clay is under pressure from the aquifer to flow into the cell not only at the base but on the side walls as shown on Attachment 11.

2. Insitu Clay Barrier

A uniform clay deposit is the confining stratum overlying the aquifer. This clay is saturated to surface and forms an effective aquiclude.

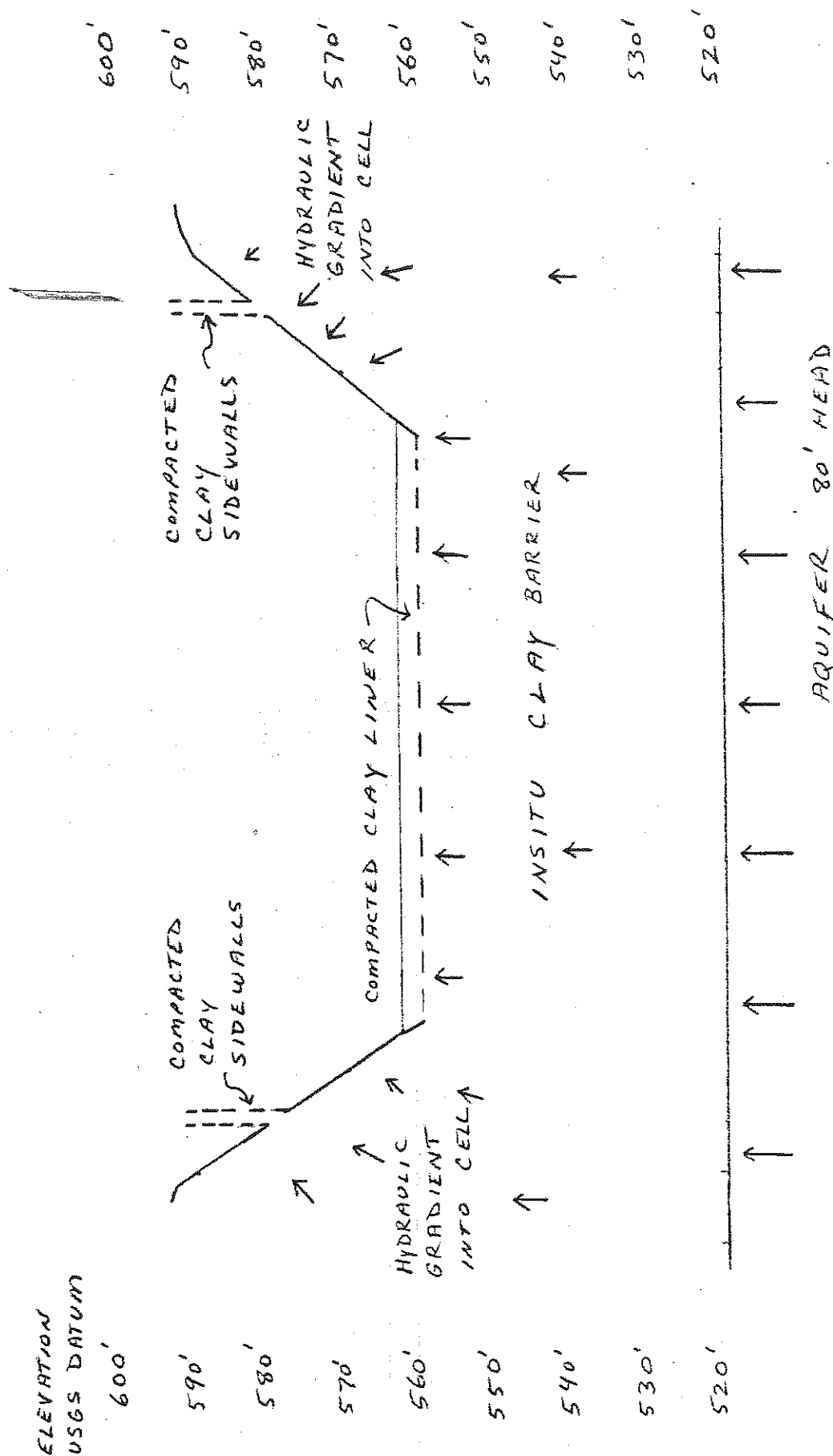
FORD MOTOR COMPANY ALLEN PARK CLAY MINE
MID 980568711

LINER DESCRIPTION

TYPICAL CELL CROSS-SECTION

SCALE 1" = 100' HORIZONTAL

1" = 40' VERTICAL



D-6c(1) Liner Description 40 CFR 270.21(b)(1) (Cont'd)

3. Recompacted Clay Liner Base

The bottom of the cell will receive a compacted clay base to achieve the appropriate bottom slopes necessary for the proper functioning of the leachate collection system. The final bottom cell elevation is designed to be at 560.0 ft. (MSL). (See also engineering drawings, Attachment 14.)

4. Clay Sidewalls

The clay sidewalls are formed by the insitu clay strata, and extend up to the 580 elevation. Compacted clay is then keyed into the natural clay and the sidewalls are extended to final surface grade. The compacted sidewalls will be ten feet wide, installed in 12 inch lifts, each lift compacted to 90% of the maximum dry density as determined in accordance with the Modified Proctor test (ASTM D-1557).

D-6c(2) Liner Location Relative to High Water Table 40 CFR 270.21(b)(1)

The soil stratum overlying the bedrock at the site is silty clay with fine sands blanketing the top five feet of the surface. These sands are water bearing and could be considered a water table. As discussed in Exhibit H of Attachment 15, our consultant considers this to be a "minor" water table that will not affect landfill operation.

D-6c(3) Calculation of Required Soil Liner Thickness 40 CFR 270.21(b)(1)

The soil liner thickness (insitu silty clay and compacted clay) is approximately 40 feet. Refer to Exhibit D of Attachment 15 for the appropriate calculations.

D-6c(4) Liner Strength Requirements 40 CFR 270.21(b)(1)

Minimum strength requirements for liners are designed to protect the integrity of synthetic liners from differential stresses. The integrity of the site's clay liner, which is 40 feet thick, cannot be compromised by these stresses. Movement of only a few inches by a synthetic liner could cause failure, whereas with the clay liner at the subject site, such movement would be of no consequence because of the plasticity of the saturated clay.

D-6c(5) Liner Strength Determination 40 CFR 270.21(b)(1)

Not applicable because installation of a synthetic liner is not needed at this site.

D-6c(6) Liner/Waste Compatibility Testing Results 40 CFR 270.21(b)(1)

Refer to our consultant's report, Exhibit D of Attachment 15, which indicates that the negative hydraulic conditions at the site obviates the need for liner compatibility testing.

D-6c(7) Liner Installation 40 CFR 270.21(b)(1)

The liner installation involves the compaction of natural clay soils on the base of the cell and the construction of clay sidewalls at surface grades.

D-6c(7)(a) Synthetic Liner Seaming 40 CFR 270.21(b)(1)

Not applicable.

D-6c(7)(b) Soil Liner Compaction 40 CFR 270.21(b)(1)

Clay compaction necessary for both the liner base and sidewalls will be as follows:

1. Place clay in lifts not to exceed 12 inches.
2. Compact the clay to 90% of maximum dry density as determined in accordance with the Modified Proctor Test ASTM D-1557.
The moisture content of the clay should be kept within 2 percent below and 5 percent above the optimum as defined by ASTM D-1557.
3. Utilize clay soils that have a permeability coefficient of 1×10^{-7} cm/sec or less.

D-6c(7)(c) Installation Inspection/Testing Program 40 CFR 270.21(b)(1)

Testing of Clay Soils

- | | |
|--|--|
| (1) Moisture/density | 1 test per 1,000 yd. ³ or per lift, whichever is less. ASTM D-2922 |
| (2) Atterberg limits and grain size analysis (sieve and hydrometer analysis) | 1 test per 10,000 yd. ³ or per change of material. ASTM D-423, 424, 422 |
| (3) Modified Proctor soil compaction curve | 1 test per 10,000 yd. ³ or per change of material. ASTM D-1557 |
| (4) Permeability coefficient | 1 test per 10,000 yd. ³ or per change of material, U.S. Army Corp. of Engineers. EM 1110-2-1906 |

Installation Inspection

A soil testing service will be employed to provide full time inspection and testing of the soils and installation procedures to assure that the liner system as installed meets the design requirements.

D-6c(8) Liner Coverage 40 CFR 270.21(b)(1)

Since the clay deposit is an integral part of the liner system, this question is not applicable.

D-6c(9) Liner Exposure Prevention 40 CFR 270.21(b)(1)

The natural clay liner can withstand exposure to the elements as evidenced by the stable integrity of the other existing cell liners at the facility.

D-6c(10) Synthetic Liner Bedding 40 CFR 270.21(b)(1)

Not applicable.

D-6d(1) Liner Foundation Design Description 40 CFR 270.21(b)(1)

The liner foundation is a uniform lacustrine clay bed resting on limestone bedrock of the Dundee formation. The clay is approximately 70 feet thick beneath the cell bottom. Refer to Attachment 15 for the soil testing data and hydrogeological report.

D-6d(2) Subsurface Exploration Data

- . Test borings - 15 borings into liner foundation depth to confirm depositional uniformity and soil engineering characteristics.
- . Test pits - The adjacent 200 acres have been excavated and back-filled in a manner similar to the proposed Cell II. Hazardous Waste Cell I operating under interim status is the operational model to follow. It was constructed identically to Cell II and provides proof of the liner's stability and physical integrity.
- . Geophysical exploration - The seismic survey on the cell bottom indicates uniform soil to bedrock, which is an estimated 70 feet below well bottom.

. Engineering characteristics of the foundation materials are well known and tested in the area, due to the abundance of constructed engineering projects. For example:

1. Storm sewer installed underneath Oakwood Blvd. at the approximate elevation of the aquifer.
2. Footings for the major buildings in the area.
3. Borings for the adjacent highway construction.

The soil test work done on these projects verify the engineering characteristics of the liner foundation materials which have been presented in Attachment 15.

D-6d(3) Laboratory Testing Data 40 CFR 270.21(b)(1)

Site specific laboratory test data is provided in Attachment 15.

Additional soil test results are available on the adjacent constructed engineering projects.

D-6d(4) Engineering Analyses 40 CFR 270.21(b)(1)

Refer to Attachment 12 and the following discussions on settlement potential, soil stability, and bottom heave for an analysis of the engineering characteristics of the site.

D-6d(4)(a) Settlement Potential 40 CFR 270.21(b)(1)

Since 35 feet of soil was excavated to create the cell, the liner foundation has been pre-loaded or consolidated so that settlement of the liner foundation should not occur. A demonstration of this aspect is provided by the observation of Cell I.

Inactive Salt Mines:

The mineral rights on the property are owned by Ford Motor Company. A present lease agreement exists for the mining of salt in a Niagran evaporiate seam which is situated 1,137 feet below the surface. The reserves have been mined by International Salt Company.

Mining is done by room and pillar method with 80' x 80' pillars and 50' rooms. This amounts to 62% extrzction. The seam is 22' - 25' thick and 40" - 100" is left for ceiling support. During the life of the mining operation, there has never been evidence of surface subsidence and none is anticipated in the future. International Salt Company has displayed the prudent mining practice necessary to ensure the sound integrity of the Allen Park Clay Mine landfill.

D-6d(4)(b) Bearing Capacity and Stability 40 CFR 270.21(b)(1)

Refer to Exhibit H of Attachment 15 which provides the standard penetration values of the soil. The results of the standard penetration tests indicate the relative density and comparative consistency of the soils, and thereby provide a basis for estimating the relative strength and compressibility of the soil profiles.

D-6d(4)(b) Bearing Capacity and Stability 40 CFR 270.21(b)(1) (Cont'd)

The adequate bearing capacity and stability indicated by the standard penetration values is verified by the experience provided by the adjacent landfilling operation.

D-6d(4)(c) Potential for Bottom Heave or Blow-Out 40 CFR 270.21(b)(1)

Hydrostatic pressure from the confined aquifer does provide the potential for a bottom blow-out if the cell bottom is located too close to the aquifer. It should be noted that the excavation has already taken place, and the cell bottom has been exposed without consequence for a period of several years. Refer to the following Attachment 12 for engineering analysis of the potential.

D-6d(4)(d) Construction and Operational Loading 40 CFR 270.21(b)(1)

Demonstration that the liner foundation is capable of adequate support is provided by the present operation of Cell I. Cell I is identical to Cell II, and the Caterpillar D-7 bulldozer has no problem working Cell I.

Ford Allen Park Clay Mine

MID 980568711

Cell Bottom Stability

Piezometric Level = 601'

Bottom of Clay Liner = 521'

Upward Pressure = $(601 - 521) \times 62.4 = 4,992$ PSF

Downward Pressure = $(\text{bott. elev.} - 521) \times 130$ PCF

For F.S. = 1.0, Downward Pressure = 4,992 PSF

Bottom Elev. (F.S. = 1.0) = $\frac{4,992}{130} + 521 = 559.4'$

Lowest Elev. of Natural Clay Liner Surface = 560'

D-6e Leachate Collection and Removal System 40 CFR 270.21(b)(1)

The design specifications and supporting calculations are provided as Attachment 13. The design engineering drawings for the system are provided as Attachment 14.

D-6e(1) System Design and Operation 40 CFR 270.21(b)(1)

The leachate collection system is constructed of the following components:

1. Collection bed
2. Gravel packed collection pipe
3. Concrete sump and risers
4. Pump and discharge hose

Collection Bed

The collection bed rests on a sloped clay liner with grades greater than 1% to the collection pipes and manhole sump. The granular drainage blanket shall be placed as shown on the design plans. It shall consist of Michigan Department of Transportation (MDOT) Class II Granular Material, based on grain size testing of at least one sample per every 5,000 cubic yards, measured in place. This layer shall be at least 12 inches thick.

Gravel Packed Collection Pipes

The collector pipe system shall be constructed as shown in the design plans. The collector pipe shall consist of nominal 4 inch diameter SDR 7.3 HDPE (PPI rating of 3408) perforated pipe. Perforations shall be 0.25 inches in diameter and will provide at least 0.25 square inches of open area per foot of pipe length. The gravel backfill for the pipe trenches shall consist of MDOT Series 6A or 17A coarse aggregate. This backfill shall be placed and compacted by hand. Geotextile filter

Gravel Packed Collection Pipes (Cont'd)

cloth shall be placed as shown in the design plan. It shall consist of non-woven, needle-punched polypropylene geotextile possessing an equivalent opening size no greater than the opening size of a #70 mesh standard sieve and a permeability no less than 0.1 cm/sec.

Concrete Sump and Risers

The concrete sump is 96 inches in diameter and rests on a concrete cookie slab as shown on the design engineering drawings (Attachment 14). The sump will be coated with epoxy so as to be resistant to the leachate that will be generated. The epoxy will prevent the sump from coming in direct contact with the leachate. The sump is designed to hold at least 1,000 gallons of leachate, while creating a head of less than one foot on the liner. The concrete risers are five foot in diameter.

Pump and Discharge Hose

The sump pumps to be used will be electrical submersibles with float switch mechanisms automatically controlled. The float switch activates the pump when a thousand gallons of leachate collect in the sump and automatically shuts off the pump when the sump is empty. The discharge line will be connected to an equalization tank which meets the definition of "wastewater treatment unit" as specified in 260.10. Discharge will be to the Detroit Water and Sewerage Department public sewer.

D-6e(2) Maximum Leachate Head 40 CFR 270.21(b)(1)

Attachment 13 provides the design calculations and specifications indicating that the leachate will not exceed one foot depth over the liner. In the event that it becomes necessary to reduce maximum leachate head to less than one foot, pipe spacing may have to be reduced. The water balance provides the data necessary to determine the collection pipe spacing. The permeability of the drainage blanket provides adequate flow to the collection pipes. The pipe flow capacity has been adequately designed to handle the anticipated leachate flow.

D-6e(3) Chemical Resistance 40 CFR 270.21(b)(1)

The system components have been selected for their chemical resistance to the proposed wastes. The wastes are inorganic heavy metal oxides and silicates except for coal tar sludge. The collection pipe (high density polyethylene) is resistant to the heavy metals as well as the organic chemicals (phenol, naphthalene) expected to be present in the leachate. The same is true of the polypropylene filter cloth around the collection pipe and the epoxy applied to the concrete sump. The manufacturer's chemical resistance specifications are provided in Attachment 13.

D-6e(4) Strength of Materials 40 CFR 270.21(b)(1)

The collection pipe is shown to have adequate strength to prevent collapse under the expected static and dynamic loadings as indicated in Attachment 13.

D-6e(5) Prevention of Clogging 40 CFR 270.21(b)(1)

The collection system was designed to prevent clogging by utilizing proper liner gradients, collection pipe slot sizes, gravel packing specifications and filter cloth as shown in Attachment 13.

D-6e(6) Installation 40 CFR 270.21(b)(1)

The installation will be under the supervision and direction of a registered professional engineer who will be required to certify that the construction was followed in accordance with the design plans. Inspection program will include verification of:

1. proper liner slopes
2. specified materials are used
3. materials installed in accordance with design plans (Attachment 13).

D-6e(7) Maintenance 40 CFR 270.21(b)(1)

Implementation by the facility personnel of an inspection program to identify maintenance problems will assure timely corrective actions can be made. Such inspections will include a review of:

1. operation of sump pump
2. operation of power supply
3. operation of float switch mechanism
4. clogged collection pipes (clean-outs)
5. incidents of vandalism

Daily inspections now being performed will be expanded to include these additional areas of concern.

DESIGN SPECIFICATIONS -
CELL II LEACHATE COLLECTION SYSTEM
ALLEN PARK CLAY MINE LANDFILL

I. COLLECTOR PIPE SYSTEM.

- A. A collector pipe system shall be constructed as shown in the design plans.
- B. The collector pipes shall consist of nominal 4-inch diameter SDR 7.3 HDPE (PPI rating of 3408) perforated pipe. Perforations shall be 0.25 inches in diameter or width and will provide at least 0.25 square inches of open area per foot of pipe length.
- C. Granular backfill for the pipe trenches shall consist of MDOT Series 6A or 17A coarse aggregate. This backfill shall be placed and compacted by rodding and tamping by hand.
- D. A geotextile filter shall be placed as shown in the design plan. It shall consist of non-woven, needle-punched polypropylene geotextile possessing an equivalent opening size no greater than the opening size of a #70 standard sieve and a permeability no less than 0.1 cm/sec.

II. GRANULAR DRAINAGE BLANKET

A granular drainage blanket shall be placed as shown on the design plans. It shall consist of MDOT Class II Granular Material, based on grain-size testing of at least one sample per every 5,000 cubic yards, measured in place. This layer shall be at least 12 inches in thickness.



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JOB	<u>Allen Park Clay Mine</u>	PROJECT NO.	<u>84185</u>	SHEET NO.	<u>1/13</u>
SUBJECT	<u>Leachate Collection System</u>	BY	<u>WRR</u>	DATE	<u>5/30/84</u>
		CHK. BY	<u>LJS</u>	DATE	<u>6/28/84</u>

LEACHATE COLLECTION SYSTEM

System will potentially be subject to greatest flow prior to placement of final cover. The worst case will occur when filling is essentially complete and relatively flat, final surface slopes are formed. It is anticipated that run-on will be prevented and run-off will be diverted from the collection system's granular bed prior to completion of cell filling.

The water balance included herewith and performed by Rouge Steel Co. estimates that a max. monthly rate of percolation will occur in February. This will not reach the collection system at once. Use an average daily flow for the max. month.



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JOB Allen Park Clay Mine PROJECT NO. 84185 SHEET NO. 2/12
 SUBJECT Leachate Collection System BY WRR DATE 5/30/84
 CHK. BY LJS DATE 6/28/84

Alternative Water Balance - Intermediate Cover

Assume 40% of precipitation evaporates each year (Fenn, et al., 1975) because of bare soil - no vegetation to assist evapotranspiration.

Month	J	F	M	A	M	J	J	A	S	O	N	D	Totals
P	53	54	62	68	85	84	79	71	68	63	59	57	803 mm
C _{so}	0.3	.3	.3	.28	.27	.25	.2	.2	.25	.27	.28	.3	
SRO	16	16	19	19	23	21	16	14	17	17	17	17	212
Evap.	21	22	25	27	34	34	32	28	27	25	24	23	322
PERC	16	16	18	22	28	29	31	29	24	21	18	17	269 mm

$$\text{Max. rate} \approx \frac{31 \text{ mm}}{31 \text{ days}} = 1 \text{ mm/day}$$

$$\text{Max rate from previous water balance} = \frac{38 \text{ mm}}{28 \text{ days}} = 1.36 \text{ mm/day}$$

$$\text{Use } FS = 1.5 \rightarrow q_{\text{design}} = 1.5 \times 1.36 = 2.0 \text{ mm/day}$$

$$q_{\text{design}} = 2.0 \text{ mm/day} \left(\frac{\text{cm}}{10 \text{ mm}} \right) \left(\frac{\text{day}}{24 \text{ hr}} \right) \left(\frac{\text{hr}}{3600 \text{ sec}} \right) = 2.3 \times 10^{-6} \text{ cm/sec}$$

Check upward flow from aquifer into cell -

$$K_{\text{ave}} \approx 2.6 \times 10^{-8} \text{ cm/sec} \quad \alpha \approx \frac{604 - 555}{555 - 521} = 1.4$$

$$q_{\text{upward}} \approx 2.6 \times 10^{-8} \text{ cm/sec} (1.4) = 3.7 \times 10^{-8} \text{ cm/sec}$$

This is less than 2% of $q_{\text{design}} \rightarrow$ Negligible



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JOB Allen Park Clay Mine PROJECT NO. 84185 SHEET NO. 3/13
SUBJECT Leachate Collection System BY WRB DATE 5/30/84
CHK. BY LJS DATE 6/28/84

Class II granular material is to be used in
LC system. See attached data (MDOT, 1984).
Class II → primarily fine sand with max. of
7% silt or clay-sized material
Use $K \approx 1 \times 10^{-2}$ cm/sec (Matrecon, 1980)

$$q/K = \frac{2.3 \times 10^{-6} \text{ cm/sec}}{1 \times 10^{-2} \text{ cm/sec}} = 2.3 \times 10^{-4}$$

$$q/K = 2.3 \times 10^{-4} = \left(\frac{h}{b}\right)^2 \quad h_{\max} \leq 1 \text{ ft.}$$

$$b^2 = \frac{1 \text{ ft}^2}{2.3 \times 10^{-4}} \quad b = 66 \text{ ft} \rightarrow \text{Max spacing} = 132 \text{ ft}$$

$$\text{Use } 110 \text{ feet} \rightarrow h^2 = \left(\frac{110}{b}\right)^2 (2.3 \times 10^{-4}) \quad h = 0.70 \text{ ft}$$

$$FS = \frac{1.0 \text{ max}}{0.7 \text{ est.}} = 1.44 \quad \text{OK}$$

Use drain spacing of 110 feet

(Drain invert at or below surrounding
cell liner)



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JOB Allen Park Clay Mine PROJECT NO. 24125 SHEET NO. 4/13
 SUBJECT Leachate Collection System BY WRB DATE 6/26/84
 CHK. BY LT DATE 6/28/84

Check end cells:

Increase base slope across cell - flow distance to pipe is approx. 70 feet.

$$h_{max} = \frac{L\sqrt{c}}{2} \left[\frac{\tan^2 \alpha}{c} + 1 - \frac{\tan \alpha}{c} \sqrt{\tan^2 \alpha + c} \right]$$

(Moore, 1980)

$$c = \frac{g}{K_s} = \frac{2.3 \times 10^{-6} \text{ cm/sec}}{1 \times 10^{-2}} = 2.3 \times 10^{-4}$$

$$L = 2(70) = 140 \text{ ft.}$$

$$h_{max} \leq 1 \text{ ft}$$

$$h_{max} = \frac{140 \text{ ft} \sqrt{2.3 \times 10^{-4}}}{2} \left[\frac{\tan^2 \alpha}{2.3 \times 10^{-4}} + 1 - \frac{\tan \alpha}{2.3 \times 10^{-4}} \sqrt{\tan^2 \alpha + 2.3 \times 10^{-4}} \right]$$

α	$\tan \alpha$	h_{max}
5°	.087	.535
3°	.052	.541
1°	.017	.605

} < 1 ft

End cells are OK with flow distance of 70 feet and base slopes greater than approx. 2%



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JOB Allen Park Clay Mine PROJECT NO. 84185 OW SHEET NO. 5/13
SUBJECT Leachate Collection System BY LJS DATE 6-18-84
CHK. BY WRP DATE 6/20/84

Filter Requirements for Class II sand

Reference: Giroud (1981)

See grain size information on following page.

Retention criterion -

$$\frac{O_{95}}{d_{50}} \leq \frac{18}{U}$$

O_{95} - 95% geotextile opening size (95% of the openings are smaller than O_{95})

d_{50} - 50% soil size

U - soil uniformity coeff.

$$U = \frac{d_{60}}{d_{10}}$$

Class II,
MDOT (1984)

$$U = \frac{25 \text{ mm}}{0.4 \text{ mm}} = 62.5$$

$$U = \frac{0.4 \text{ mm}}{0.08 \text{ mm}} = 5.0$$

$$d_{50} = 12 \text{ mm}$$

$$d_{50} = 0.3 \text{ mm}$$

$$\frac{O_{95}}{d_{50}} \leq \frac{18}{U}$$

$$O_{95} \leq 3.5 \text{ mm}$$

$$O_{95} \leq 1.1 \text{ mm}$$

based on Koerner & Welsh (1980):

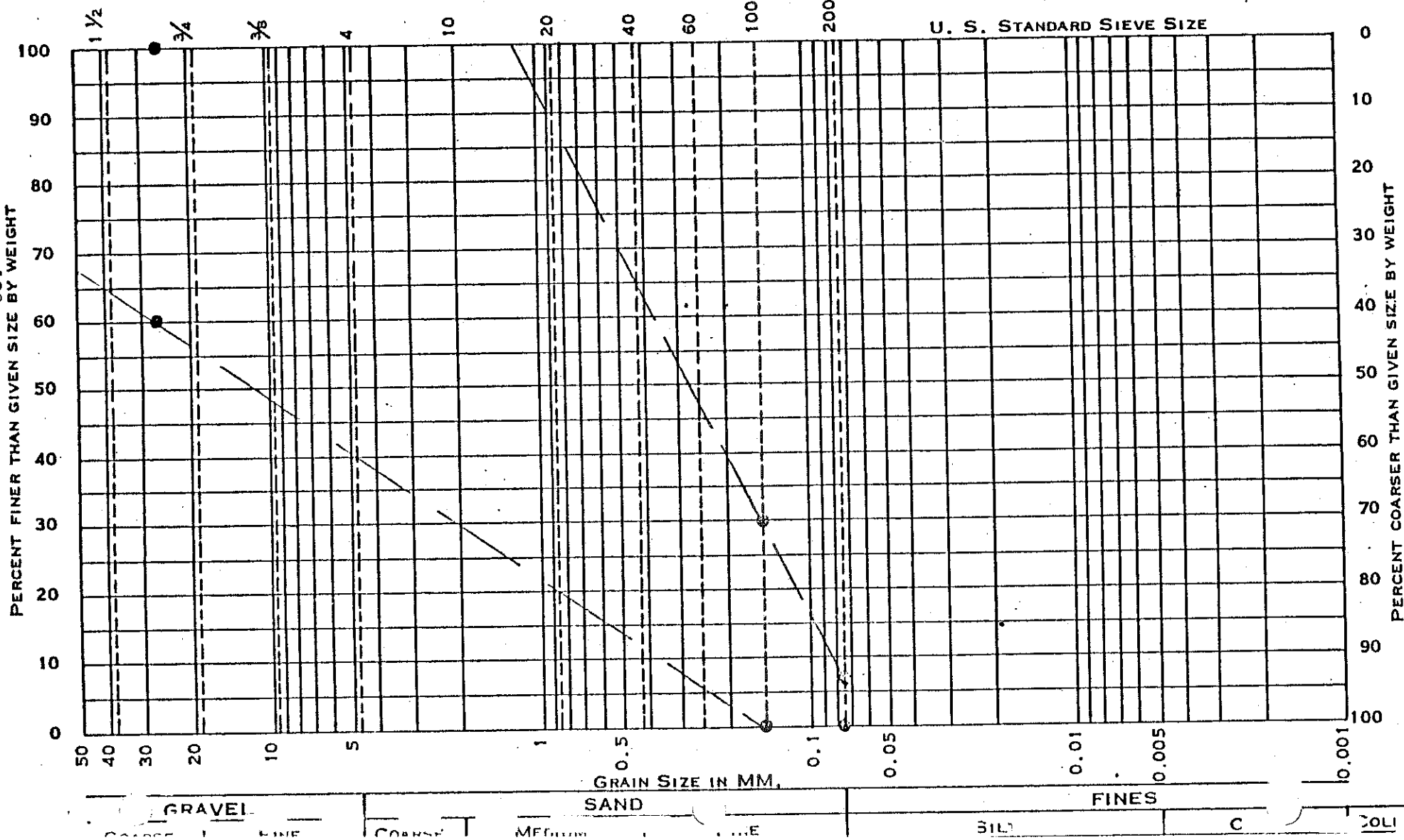
they suggest use of Army Corps of Engineers Equivalent Opening Size (EOS)

EOS is the number of the U.S. standard sieve that has openings closest in size to the filter fabric openings.

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GRAIN SIZE DISTRIBUTION CURVE

PROJECT NO. 84185 LAB SAMPLE NO. SOURCE Specs - MDOT (1984)
 PROJECT LOCATION Allen Park Clay Mine FOR Rouge Steel Company
 BORING NO. FIELD SAMPLE NO. SAMPLE DEPTH SAMPLE ELEV. (TIP)
 SAMPLE DESCRIPTION Class II Granular Materials
 DATE SAMPLED BY DATE TESTED BY CHECKED BY



Sheet No. 6/13



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JOB Allen Park Clay Mine PROJECT NO. 84185 OW SHEET NO. 7/13
SUBJECT Leachate Collection System BY LJS DATE 6-18-84
CHK. BY WRB DATE 6/20/84

$$EOS_{\text{fabric}} \leq D_{85}$$

$$EOS_{\text{fabric}} \leq 0.5 \text{ mm}$$

Use a common EOS of 70. Satisfies EOS & O_{95} .
(EOS also refers to O_{95} of the fabric.)

Permeability criterion -

coeff. of permeability of the soil $\approx 1 \times 10^{-2} \text{ cm/sec}$

Giroud (1981) suggests: $\frac{k_f}{k_s} \approx 10$

$$\therefore \text{permeability of filter} \geq 0.1 \text{ cm/sec}$$

Recommend using a thick, non-woven, needlepunched polypropylene filter fabric that meets the specifications;

Equivalent Opening Size = 70
Coefficient of Permeability $\geq 0.1 \text{ cm/sec}$

subject to compatibility testing.

This material will be placed between the Class II sand and the gravel material around the pipes.



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JOB Allen Park Clay Mine PROJECT NO. 84185 SHEET NO. 8/13
SUBJECT Leachate Collection System BY WLB DATE 5/30/84
CHK. BY LJS DATE 6/28/84

Examine Pipe

① Perforations are $\frac{1}{4}" \phi$

$\frac{D_{85} \text{ of drain filter}}{\text{perforation width}} \geq 2 \text{ (Mettecon, 1980)}$

$$D_{85} \geq 2(25) = 0.50 \text{ in}$$

Must have 85% or less passing the $\frac{1}{2}"$ sieve

Use MDOT (1984) Series 6A or 17A
coarse aggregate

See attached data

② Pipe flow capacity

$$\text{Grades} \geq 0.4\% \rightarrow .004$$

$$V = \frac{1.49}{n} R_h^{\frac{2}{3}} S^{\frac{1}{2}} \quad \text{Manning equation}$$

$$R_h = \frac{D}{4} = 1 \text{ in} = .083 \text{ ft} \quad (\text{if flowing full})$$

Use $n = 0.015 \rightarrow$ Conservative

$$V = \frac{1.49}{.015} (.083)^{\frac{2}{3}} (.004)^{\frac{1}{2}} = 1.20 \text{ ft/sec}$$

$$Q = 1.20 \text{ ft/sec} (\pi) \left(\frac{4}{12}\right)^2 = 0.10 \text{ ft}^3/\text{sec}$$

$$\text{Total Cell II inflow} \rightarrow 530 \text{ ft} (660 \text{ ft}) (2.3 \times 10^{-6} \text{ cm/sec}) \left(\frac{\text{ft}}{30.48 \text{ cm}}\right) = Q'$$

$$Q' = .026 \text{ ft}^3/\text{sec} \ll Q \text{ single pipe}$$

Multiple pipe system is conservative and OK



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JOB Allen Park Clay Mine PROJECT NO. 841850W SHEET NO. 9/13
SUBJECT Leachate Collection System BY ETS DATE 6-26-84
CHK. BY WRB DATE 6/27/84

Open Area on Perforated Pipe

pipe capacity $q_{design} = 2.3 \times 10^{-6} \text{ cm/sec}$
max. distance travelled = 110 ft
1 ft wide strip

$$Q = 110 \text{ ft} \times 1 \text{ ft} \times 2.3 \times 10^{-6} \text{ cm/sec}$$

$$Q = 8.3 \times 10^{-6} \text{ cfs}$$

limit entrance velocity to 0.1 ft/sec

entrance area equals

2 ; $1/4$ " ϕ holes spaced 4" apart

\Rightarrow 6 holes/ft

$$Q = VA$$

$$V = \frac{8.3 \times 10^{-6} \text{ cfs}}{6 \times \pi \left(\frac{(1.25/12)^2}{4} \right)} = 0.004 \text{ ft/sec}$$

$V < 0.1 \text{ ft/sec}$ OK



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JOB Allen Park Clay Mine PROJECT NO. 841550W SHEET NO. 10/13
 SUBJECT Leachate Collection System BY LTS DATE 6-26-84
 CHK. BY LWR DATE 6/27/84

PIPE STRENGTH

TRENCH METHOD SW-870
 (Matrecon, 1980)

q_f = vertical pressure at the base of the refuse

w_f = unit weight of the waste fill

H_f = height of fill

$$q_f = w_f H_f = 75 \text{ pcf} (65 \text{ ft}) + 5 \text{ ft} (135 \text{ ft}) = 5550 \text{ pcf}$$

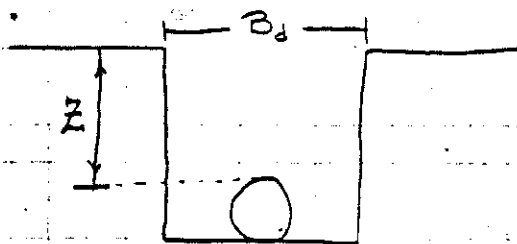
σ_v = vertical pressure on pipe

$$\sigma_v = q_f C_{us}$$

C_{us} = load coeff.

$$C_{us} = e^{-2K\mu' (z/B_d)}$$

ratio z/B_d



$$\text{let } B_d = 1 \text{ ft}$$

$$z = 1.5 \text{ ft}$$

$K\mu'$ - characteristic for a given backfill

SAND & GRAVEL - 0.165

from FIG. V-4
 (Matrecon, 1980)

$$C_{us} = 0.60$$



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JOB Allen Park Clay Mine PROJECT NO. 54185 DW SHEET NO. 11/13
SUBJECT Leachate Collection System BY LJS DATE 6-26-84
CHK. BY WRB DATE 6/27/84

σ_{v2} - vertical press. due to trench backfill

$$\sigma_{v2} = B_d (w) C_d$$

$$B_d = 1.5 \text{ ft}$$

$$w = 120 \text{ pcf}$$

$$C_d = \text{load coeff.} = 1.17 \text{ from Fig V-5 (Matrecon, 1980)}$$

TOTAL VERTICAL PRESSURE

$$\sigma_v = \sigma_{v1} + \sigma_{v2} = q_f C_{us} + B_d w C_d$$

$$\sigma_v = 5550 (0.60) + 1.0 (120) (1.17) = 3470 \text{ psf}$$

FORCE / UNIT LENGTH OF PIPE

$$W = \sigma_v B_c \quad B_c - \text{outside dia.}$$

$$W = 3470 \text{ psf} \left(\frac{4.5''}{12''} \right) = 1301 \text{ lb/ft}$$
$$= 108.4 \text{ lb/in}$$

choose pipe: HDPE, PPI rating of PE 3408

SDR 7.3

nominal dia. = 4"

actual outside dia. = 4.500"

min. wall thickness = 0.616"

wt. (lb/ft) = 3.251

See attached data.



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JOB Allen Park Clay Mine PROJECT NO. 84195 OW SHEET NO. 12/13
SUBJECT Leachate Collection System BY LTS DATE 6-26-84
CHK. BY WRB DATE 6/27/84

check deflection:

$$\Delta y = D_e \frac{K W r^3}{EI + 0.061 E' r^3}$$

$D_e = 1.5$ lag factor

$K = 0.10$ bedding constant

$E' = 300$ psi

$E = 30,000$ psi (long term modulus, HDPE)

$I = \frac{t^3}{12}$

$r = \text{mean radius} = 1.9"$

$$\Delta y = 1.5 \frac{0.1 (108.4) (1.9)^3}{30,000 \left(\frac{0.616^3}{12} \right) + 0.061 (300) (1.9)^3}$$

$\Delta y = 0.157"$ vertical deflection

$$\left(\frac{\Delta y}{B_c} \right) * 100\% = 3.5\% \text{ deflection}$$

< 5% OK

Safety Factor

The deflection of the pipe is directly proportional to the load $\Rightarrow \Delta y \propto W$

WPCF - ASCE recommends

$$\frac{W_{max}}{W} \geq 1.25$$

check Δy :

$$\frac{\Delta y_{max}}{\Delta y} = \frac{0.05}{0.035} = 1.4 > 1.25 \text{ OK}$$

Subject to compatibility testing.



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JOB Allen Park Clay Mine PROJECT NO. 84185 SHEET NO. 13/13
SUBJECT Leachate Collection System BY LTS DATE 6-27-84
CHK. BY WRP DATE 6/28/84

References

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**1984
STANDARD
SPECIFICATIONS
FOR
CONSTRUCTION**



8.01.03

c. **Type IP, I(PM), IP-A, and I(PM)-A Pozzolan Cements.**—These portland cements shall conform to the requirements of ASTM C 595.

d. **White Cement.**—This portland cement shall conform to requirements for Type I of ASTM C 150, except that it shall contain not more than 0.55 percent of ferric oxide (Fe_2O_3) by weight. The requirements for Gillmore setting time test and compressive strength through the 28-day test shall apply.

8.01.04 Masonry Cement.—Masonry cement shall conform to ASTM C 91.

8.01.05 Hydrated Lime.—Hydrated lime shall conform to ASTM C 207.

8.01.06 Ground Blast-Furnace Slag.—Ground blast-furnace slag shall conform to the requirements of ASTM C 989, Grade 100. It shall be used only as a blending material with Type IA or Type I portland cement, and only when approved on a project-by-project basis.

8.02 AGGREGATES

8.02.01 General Requirements.—Aggregates may be inspected at the producing plant and when received on the job. Such material shall not be used until approval has been received from the Engineer. Approval of aggregates at the producing plant does not constitute a waiver of the Department's right to reject them on the job. Aggregates which have been tested and approved for use in State work shall not be used in other work. When the circumstances require that the material be sampled from the hauling unit, the Contractor shall furnish a stairway and platform to provide safe access to the material in the hauling unit.

Aggregates shall be transported from the storage site to the work in vehicles so constructed and maintained as to prevent loss, contamination, or segregation of materials after loading and measuring.

8.02.02 Testing.—Testing will be accomplished by the specific methods specified throughout the Section and by the following general methods:

Sieve Analysis of Mineral Filler AASHTO T 37
Sampling of Soils AASHTO T 86
Particle Size Analysis of Soils AASHTO T 88
Sieves (Square Openings) ASTM E 11, E 323

The determination of deleterious particles will be done in accordance with Department methods.

Definitions of Terms.—Terms used in the inspection and testing of aggregates are defined as follows:

8.02.02

1. Natural Aggregates.—Natural aggregates shall be obtained from stone quarries, gravel deposits, or waste mine rock. Only such quantities of clay lumps and roots as are determined by the Engineer to have no deleterious effect upon the finished product will be permitted.

2. Slag Aggregates.—Slag aggregates are by-products formed in the production of iron, copper, and steel. When the word "slag" is used alone, it shall be understood to mean iron blast-furnace slag or reverberatory-furnace slag.

Iron Blast-Furnace Slag is defined as a synthetic non-metallic by-product produced simultaneously with pig iron in the blast furnace; the slag consists principally of a fused mixture of oxides of silica, alumina, lime, and magnesia.

Reverberatory-Furnace Slag is defined as the non-metallic by-product resulting from refining copper ore.

Steel-Furnace Slag is a synthetic aggregate produced as a by-product of basic oxygen, electric, or open hearth steel-making furnaces; steel furnace slag consists principally of a fused mixture of oxides of calcium, silica, iron, alumina, and magnesia. Steel-furnace slag shall meet the same gradation and physical requirements as specified for iron blast-furnace slag and reverberatory-furnace slag.

3. Soft Particles.—Soft particles are those particles which are structurally weak or which are found to be non-durable in service. Soft particles include shale, siltstone, friable sandstone, ochre, coal, and clay-ironstone, except that clay-ironstone particles will not be classified as soft particles in the 9, 25, 28, and 31 Series aggregates used for bituminous mixtures and seal coats.

4. Crushed Particles.—A crushed particle is one which has at least one fractured face, except for those coarse aggregates where the size of the sieve on which the aggregate shall be retained before crushing is specified, in which case essentially all surfaces of the particle shall be fractured.

Determination of crushed particles in aggregate produced by crushing portland cement concrete will be based on the presence of broken faces on the particle and not on the fact that it is a fragment broken from concrete.

All sandstone particles will be considered as crushed particles.

8.02.03 Coarse Aggregates for Portland Cement Concrete, No. 12 Bituminous Mixtures, and Bituminous Seal Coats.—Coarse aggregates for portland cement concrete, No. 12 bituminous mixtures, and bituminous seal coats (Michigan Series No. 6, 9, 17, 25, 26, 28, and 31) shall be obtained from natural aggregate or slag sources. Coarse aggregate produced by crushing portland cement concrete salvaged from the removal of concrete pavements, curbing, sidewalk, and similar structures from Department projects may be used in No. 12 bituminous mixtures other than top course mixtures and in portland cement concrete mixtures other than those requiring the use of 6AA aggregate.

The aggregates shall conform to the grading requirements in Table 8.02-1, the physical requirements in Table 8.02-2, and the following additional requirements.

Slag for concrete or bituminous coarse aggregate, conforming to the grading to be used in the mixture, shall have a unit weight of not less than 75 pounds per cubic foot as determined by ASTM C 29, Rodding Procedure.

Coarse aggregate produced by crushing concrete shall not be contaminated by base material picked up with the concrete. The presence of foreign materials, such as brick, wood, or plaster, in excess of 0.25 percent will be considered as evidence of contamination and shall result in rejection of the aggregate. Pieces of steel reinforcement may be present provided they pass the maximum sieve size of the grading without hand manipulation. The quantity of bituminous material in the crushed concrete shall not exceed 5 percent for aggregate to be used in concrete mixtures nor 15 percent for aggregate to be used in bituminous mixtures. A fragment of crushed concrete containing some bituminous material, soft particles, or chert will be considered as if the whole fragment was composed of the objectionable material. The crushed concrete shall conform to the physical requirements shown for gravel and stone in Table 8.02-2.

8.02.04 Dense-Graded Aggregates.—Dense-graded aggregates (Michigan Series No. 20, 21, 22, 23, and 35) shall conform to the grading requirements in Table 8.02-1, the physical requirements in Table 8.02-2, and the following additional requirements.

The 20 Series and 35A aggregates are used in bituminous mixtures.

The 21AA, 21A, 22A, and 23A aggregates are used for

aggregate base course, aggregate surface course, aggregate shoulders, and aggregate approaches.

Dense-graded aggregate shall consist of gravel, stone, slag, or crushed concrete, in combination with fine aggregate as necessary to meet the gradation requirements.

Dense-graded aggregate produced by crushing portland cement concrete shall not contain building rubble as evidenced by the presence of more than 1.0 percent brick, wood, plaster, or similar materials. Pieces of steel reinforcement may be present provided they pass the maximum sieve size of the grading without hand manipulation. The crushed concrete shall conform to the physical requirements shown for gravel and stone in Table 8.02-2.

When producing bituminous mixtures for top courses, aggregate produced by crushing portland cement concrete will not be permitted for the portion of the 20 Series aggregate coarser than the $\frac{3}{4}$ inch sieve.

The portion of the 20 Series aggregates passing the $\frac{3}{4}$ inch sieve shall be natural sand, stone sand, slag sand, sand produced by crushing portland cement concrete, or stamp sand. Only a negligible amount of organic material will be permitted. When producing bituminous mixtures for top courses, the amount of stone sand from crushed carbonate (limestone or dolomite) sources shall not exceed 10 percent of the total weight of the aggregate in the mix.

The material shall be stockpiled in such manner that the material may be removed from the stockpile by methods which will provide aggregate having a uniform gradation.

8.02.05 Open-Graded Drainage Course (OGDC) Aggregates.—OGDC aggregates shall conform to the grading requirements in Table 8.02-1, the physical requirements in Table 8.02-2, and the following additional requirements.

OGDC aggregate shall be obtained from natural aggregate, crushed concrete, iron blast-furnace slag, or reverberatory-furnace slag sources.

Aggregate from crushed concrete shall be produced by crushing concrete salvaged from highway-type structures such as pavements, curbing, gutters, and sidewalks. The salvaged concrete shall not be contaminated by base material picked up with the concrete. Presence of brick, wood, plaster, or similar materials in excess of 1.0 percent will be considered as evidence of contamination and shall result in rejection of the aggregate. Pieces of steel reinforcement may be present provided they pass the maximum sieve size of the grading without hand manipulation.

Table 8.02-1 Grading Requirements for Coarse Aggregates, Dense-Graded Aggregates, and Open-Graded Aggregates 1984

MATERIAL	MICHIGAN SERIES	CLASS	ITEM OF WORK BY SECTION NUMBER ^a	(b)	SIEVE ANALYSIS(b) (ASTM C 136) TOTAL PERCENT PASSING										PERCENT LOSS BY WASHING(b) (ASTM C 117)
					1 1/2" 37.5mm	1" 25.0mm	3/4" 19.0mm	1/2" 12.5mm	3/8" 9.5mm	No. 4 4.75mm	No. 8 2.36mm	No. 16 1.18mm	No. 30 0.60mm		
COARSE AGGREGATES	6	AA	5.05, 7.01, 7.03		100	95-100		30-60		0-8				10 max(c)	
		A	7.01		100	95-100							5.0 max		
	9	A	7.10	1 1/4"	100	95-100	70-90		15-35	5-15			10 max(c)		
	17	A	7.01			100	90-100	50-75		0-8					
	25	A	4.06, 7.10, 7.11	1"				100	95-100	60-90	5-30	0-12		3.0 max(d)	
		B	4.06												
		C	4.06												
	26	A	7.03				100	95-100	60-90	5-30	0-12			3.0 max	
	28	B	4.06					100	95-100	25-50	0-15			3.0 max	
		C	4.06					100	85-100 ^e	20-60	0-25			3.0 max	
	31	A	4.06, 5.06, 7.10, 7.11	1"				100	95-100	35-65	0-25			3.0 max(d)	
		C	5.06, 7.11	3/4"											
DENSE GRADED AGGREGATES	20	AAA	7.10				100	95-100	65-90	55-75	45-65		20-40	0-7(d)	
		AA	7.10, 7.11				100	95-100	65-90		45-65		20-40	0-7(d)	
		A	7.10, 7.11				100		65-85		40-60		20-35	0-7(d)	
		B	7.10, 7.11				100		60-90		40-65		20-40	2-10(d)	
		C	7.10		100	80-100			55-85		30-60		15-40	0-10(d)	
	21	AA	3.01, 4.03		100	85-100		50-75			20-45			4-8(d)(e)	
		A	3.01, 4.03												

OPEN-GRADED AGGREGATES	22	A	3.01, 3.08, 3.09, 4.03			100	90-100		65-85		30-50			4-8(d)(e)(f)
	23	A	3.08, 3.09			100			60-85		25-60			9-16(d)
	35	A	7.10, 7.11						100	65-85	45-65		20-40	0-7(d)(g)
	5	G	2.08, 6.02		100			0-90		0-8				3.0 max
	8	G(h)	2.08, 6.02		100		52-100		35-65	8-40		0-12	0-8	5.0 max
	34	G	2.08, 6.02					100	90-100		0-5			3.0 max

- (a) Material before crushing shall be retained on the specified sieve.
 (b) Based on dry weights. The limits for Loss by Washing of dense-graded aggregates are significant to the nearest whole percent.
 (c) Loss by Washing of 2.0 percent permitted for material produced entirely by crushing rock, boulders, cobbles, slag, or concrete.
 (d) Quarried Carbonate (limestone or dolomite) aggregates shall not contain over 10 percent insoluble residue finer than the No. 200 sieve.
 (e) When used for aggregate base courses and the material is produced entirely by crushing rock, boulders, cobbles, slag, or concrete, the maximum limit for Loss by Washing will be increased to 10 percent.
 (f) For aggregates produced from sources located in Berrien County, the Loss by Washing shall not exceed 8 percent and the sum of Loss by Washing and shale particles shall not exceed 10 percent.
 (g) When free of clay and silt and the material is produced entirely by crushing rock, boulders, cobbles, slag, or concrete, the maximum limit for Loss by Washing will be increased to 9 percent.
 (h) OGDC Aggregate 8G shall have a coefficient of uniformity (D60/D10) equal to or greater than 4. D60 is the maximum diameter of the smallest 60 percent, by weight, of the particles and D10 is the maximum diameter of the smallest 10 percent, by weight, of the particles.

Item of Work:
 2.08 Roadway Earthwork
 3.01 Aggregate Base Courses
 3.08 Aggregate Surface Course
 3.09 Aggregate Shoulders and Approaches
 4.03 Temporary Patching with Bituminous Material
 4.06 Bituminous Seal Coats

5.05 Prestressed Concrete Beams
 5.08 Waterproofing and Protective Covers
 6.02 Underdrains
 7.01 Portland Cement Concrete
 7.03 Mortar and Concrete Patching and Resurfacing Mixtures
 7.10 Bituminous Mixtures—Plant Mixed
 7.11 Bituminous Patching Mixtures

Table 8.02-2 Physical Requirements for Coarse Aggregates, Dense-Graded Aggregates, and Open-Graded Aggregates
1984

MICHIGAN SERIES	CLASS	GRAVEL AND STONE(1)						SLAG(1)(2)	
		Crushed Material, min (3)(4)	Loss, max. Los Angeles Abrasion (AASHTO T 96)	Soft Particles, max (3)	Chert, max (3)(5)	Sum of Soft Particles and Chert, max (3)(5)	Freeze-Thaw Durability, min. (ASTM C 666, Procedure B)(6)(7)	Sum of Coke and Coal Particles, max (3)	Freeze-Thaw Durability, min. (ASTM C 666, Procedure B)(6)
8	AA		40	2.0(8)		4.0	20	1.0	20
	A		40	3.0(8)	7.0	9.0	20	1.0	20
9	A	95	40	5.0				1.0	
17	A		40	3.5(8)	8.0	10.0	20	1.0	20
25	A(9)	95	40	5.0				1.0	
	B	50	40	5.0				1.0	
	C		40	5.0				1.0	
26	A		40	2.0(8)		4.0	20	1.0	20
28	B	60	40	6.0				1.0	
	C	40	40	6.0				1.0	
31	A(9)	95	40	5.0				1.0	
	C	95	40	5.0				1.0	
20	AAA(9)	60	40						
	AA(9)	40	40						
	A(9)	25	40						
	B		40						
	C		50						
21	AA	95	50						
	A	25	50						
22	A	25	50						
23	A		50						
35	A(9)	60	40						
5	G	(10)	40(11)						
8	G	(10)	40(11)						
34	G	(10)	40(11)						

- (1) All values in percent.
- (2) Slag shall consist of clean, tough, durable pieces, reasonably uniform in density and quality. The aggregates shall contain no free (unhydrated) lime.
- (3) Determined by dividing the weight of the particles picked by the weight of that portion of the sample from which they were selected.
Clay-ironstone particles are included in the soft particles picked for the 8, 17, and 26 Series aggregates.
Clay-ironstone particles are not included in the soft particles picked for the 9, 25, 28, and 31 Series aggregates.
- (4) The percentage of crushed material will be determined on that portion of the sample retained on all sieves down to and including the $\frac{1}{4}$ -inch sieve for Aggregate Series 21 and 22 and including the No. 4 sieve for Aggregate Series 5, 8, 9, 20, 25, 28, 31, 34, and 35.
- (5) Particles with nodules of chert will be considered as chert.
- (6) Aggregates intended for use in exposed concrete will be required to demonstrate, to the satisfaction of the Engineer, adequate freeze-thaw durability for the particular use, either by means of an extended field record of use in similar concrete which had similar exposure, or by accelerated laboratory freeze-thaw tests, or both.
- (7) Where freeze-thaw durability testing results in a durability factor of less than 40, the Engineer may impose more restrictive requirements on the soft and or chert particles based on Department methods, to ensure adequate durability for the material furnished.
- (8) Clay-ironstone particles shall not exceed 1.0 percent for 6AA and 26A, and 2.0 percent for 6A and 17A.
- (9) Aggregate used in the production of top course mixtures shall meet the Aggregate Wear Index (AWI) specified for the roadway. The AWI established for various aggregate sources will be based on wear track testing and/or petrographic analysis of representative samples of the aggregate. The Contractor may request approval to furnish an aggregate mixture which is a blend of an aggregate having a low AWI with an aggregate having a high AWI, the mixture shall be proportioned such that the mixture will have an AWI meeting, or exceeding, the AWI required for the roadway. The aggregates, the proportions to be used, and the procedures to be used for blending the aggregates shall be as approved by the Engineer.
- (10) When used as Granular Blanket, aggregates 5G and 34G shall have a minimum crushed content of 90 percent and aggregate 8G shall have a minimum crushed content of 75 percent.
- (11) The abrasion requirement applies to aggregates from any source (gravel, stone, crushed concrete, or slag).

8.02.06 Granular Materials for Fill and Subbase.—Granular materials for use as fill, trench backfill, subbase and filter aggregates shall consist of sand, gravel, crushed stone, foundry sand, iron blast-furnace slag, reverberatory-furnace slag, or a combination thereof conforming to the respective requirements specified herein. Granular material used in the construction of subbase may be produced from salvaged concrete provided that it meets the grading requirements and contains only negligible steel reinforcement.

When Class II material is specified, Class I material may be substituted. When Class III material is specified, Class I or Class II material may be substituted.

Material which may be cementitious or not suitable for water percolation shall not be used. Only such quantities of shale particles as are determined by the Engineer to have no deleterious effect will be permitted.

8.02.06

When used for trench backfill, no stones larger than 2 inches shall be placed within 12 inches of the pipe. Foundry sand shall be free of combustible material and may contain only negligible quantities of iron. It shall not be used for filling over or around underdrain pipe, metal utility service pipes, or conduits.

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Table 8.02-3 Grading Requirements for Granular Materials

MATERIAL	SIEVE ANALYSIS (ASTM C 136) TOTAL PERCENT PASSING [‡]									Percent Loss by Washing [‡] (ASTM C 117)
	6"	3"	2½"	2"	1"	½"	No. 4	No. 30	No. 100	
	150mm	75mm	63mm	50mm	25mm	12.5mm	4.75mm	0.60mm	0.150mm	
Class I				100	..	45-85	20-85	5-30		0-5
Class II*		100			60-100				0-30	0-7†
Class IIA*		100			60-100				0-35	0-10†
Class III	100	95-100								0-15†

‡ Based on dry weights.

* Except for use in Granular Blankets, Class IIA granular material may be substituted for Class II granular material for projects located in the following counties: Arenac, Bay, Genesee, Gladwin, Huron, Lapeer, Macomb, Midland, Monroe, Oakland, Saginaw, Sanilac, Shiawassee, St. Clair, Tuscola, and Wayne counties.

† To be determined on that portion of the sample which passes the 1-inch sieve.

-501-

8.02.06



NIPAKpipe

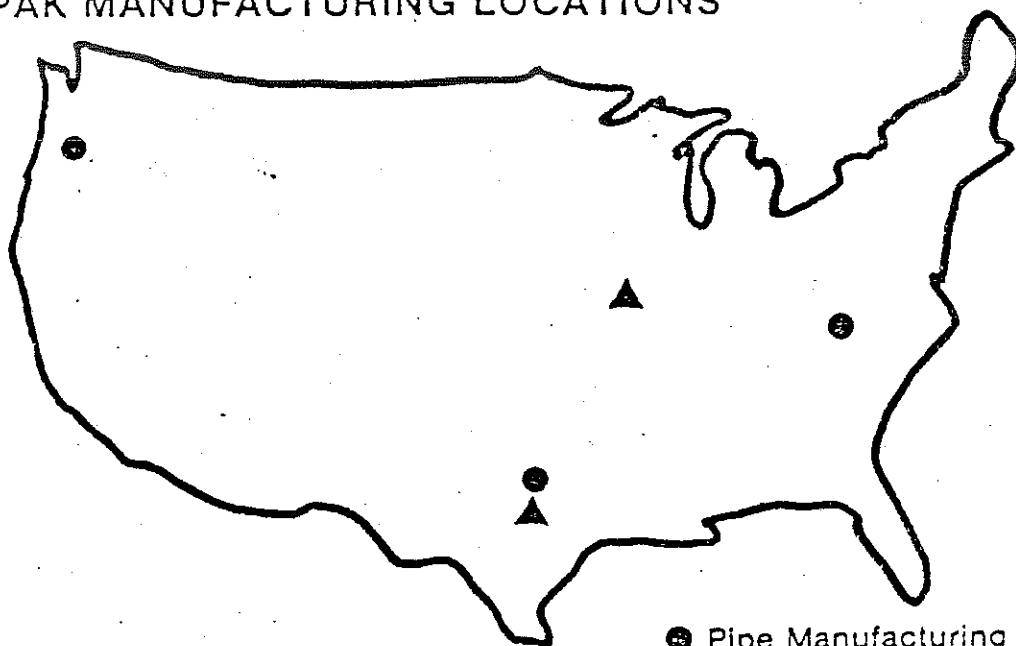
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Dimensions of Nipak PE 3408 High Density Polyethylene Pipe

TABLE 2

Nominal IPS Diameter (Inches)	Actual Outside Diameter (Inches)	SDR 7.3 (250 PSI)*		SDR 9 (200 PSI)*		SDR 11 (160 PSI)*		SDR 13.5 (125 PSI)*		SDR 15.5 (110 PSI)*	
		Minimum Wall (Inches)	Weight (lb/ft)	Minimum Wall (Inches)	Weight (lb/ft)	Minimum Wall (Inches)	Weight (lb/ft)	Minimum Wall (Inches)	Weight (lb/ft)	Minimum Wall (Inches)	Weight (lb/ft)
2	2.375	0.326	0.908	0.264	0.757	0.216	0.634	—	—	—	—
3	3.500	0.480	1.970	0.389	1.645	0.318	1.379	0.259	1.141	0.226	1.006
4	4.500	0.616	3.251	0.500	2.718	0.409	2.279	0.333	1.886	0.290	1.659
5	5.563	0.762	4.972	0.618	4.153	0.506	3.477	0.412	2.884	0.359	2.539
6	6.625	0.908	7.054	0.736	5.890	0.602	4.935	0.491	4.093	0.427	3.597
8	8.625	1.182	11.956	0.958	9.982	0.784	8.364	0.639	6.935	0.556	6.097
10	10.750	1.473	16.067	1.194	15.517	0.977	12.988	0.796	10.768	0.694	9.484
12	12.750	1.747	26.122	1.417	21.824	1.159	18.270	0.944	15.145	0.823	13.339
14	14.000	1.918	31.492	1.556	26.313	1.273	22.017	1.037	18.268	0.903	16.072
16	16.000	—	—	1.778	34.364	1.455	28.760	1.185	23.864	1.032	20.992
18	18.000	—	—	—	—	1.636	36.382	1.333	30.192	1.161	26.568
20	20.000	—	—	—	—	1.818	44.920	1.481	37.272	1.290	32.824
22	22.000	—	—	—	—	—	—	1.630	45.122	1.419	39.714
24	24.000	—	—	—	—	—	—	1.777	53.694	1.548	47.232

Nominal IPS Diameter (Inches)	Actual Outside Diameter (Inches)	SDR 17 (100 PSI)*		SDR 21 (80 PSI)*		SDR 26 (60 PSI)*		SDR 32.5 (50 PSI)*	
		Minimum Wall (Inches)	Weight (lb/ft)	Minimum Wall (Inches)	Weight (lb/ft)	Minimum Wall (Inches)	Weight (lb/ft)	Minimum Wall (Inches)	Weight (lb/ft)
3	3.500	0.206	0.922	0.167	0.756	—	—	—	—
4	4.500	0.265	1.525	0.215	1.252	—	—	—	—
5	5.563	0.327	2.327	0.265	1.908	—	—	—	—
6	6.625	0.390	3.305	0.316	2.709	0.255	2.207	0.204	1.780
8	8.625	0.508	5.604	0.411	4.588	0.332	3.742	0.266	3.022
10	10.750	0.633	8.703	0.512	7.123	0.414	5.815	0.331	4.687
12	12.750	0.750	12.231	0.608	10.032	0.491	8.180	0.393	6.600
14	14.000	0.824	14.754	0.667	12.085	0.539	9.860	0.431	7.948
16	16.000	0.942	19.276	0.762	15.779	0.616	12.878	0.492	10.369
18	18.000	1.059	24.381	0.858	19.987	0.693	16.299	0.554	13.135
20	20.000	1.176	30.083	0.952	24.643	0.769	20.097	0.615	16.201
22	22.000	1.294	36.412	1.048	29.840	0.846	24.320	0.677	19.618
24	24.000	1.412	43.343	1.143	35.504	0.923	28.946	0.738	23.330
28	28.000	1.647	59.017	1.333	48.342	1.077	39.405	0.862	31.790
30	30.000	1.765	66.75	1.429	54.68	1.154	44.54	.923	35.96
32	32.000	—	—	1.524	62.22	1.231	50.73	.985	40.91
36	36.000	2.118	97.522	1.714	78.74	1.385	64.21	1.108	52.538

*Pressure rating for water at 73.4°F, based on 1600 psi long term hydrostatic strength. See Table 17, page D-2 for additional pressure ratings.

Standard pipe lengths: 40 feet

Nipak high density polyethylene pipe is also available in coils in lengths up to 1,500 feet in eight diameters from ½" CTS to 2" IPS. 3" IPS pipe is available in coils up to 1000 feet long.

Metric sizes and special sizes are available on special order.

Although polyethylene can be deflected considerably, practical limitations of circular cleaning plugs and conventions have usually limited flexible pipe to 5% deflection. Table 23 provides the maximum allowable trench loads at 5% deflection for three different soils moduli. Earth loads for other deflection percentages will be in proportion to the values in Table 23; double for 10% deflection; half for 2.5% deflection. The 700 psi soil modulus is for 90% compaction. The 300 psi soil modulus is for 65% compaction. The 200 psi soil modulus is for loose, uncompacted fill which is uniformly placed around the pipe. A comparison of these loads with the backfill load versus backfill height of Figure 3 will determine the maximum trench depth for a particular diameter of pipe and soil modulus. With 700 psi soil modulus, the thinnest wall pipe (SDR 32.5) may be used if earthloading is the only consideration. With 300 psi soil modulus, it will be necessary for diameters over 18 inch to use SDR 21 or SDR 17 pipe or limit the trench depth. For example, an SDR 32.5 pipe of 24 inch diameter would be limited to a backfill height of 16 feet. With 200 psi soil modulus, only the smallest diameter, 6 inch, can be used with the SDR 32.5 pipe to the deepest depths. If backfill heights are limited to five feet, any diameter of SDR 32.5 may be used. For a ten foot limitation, SDR 32.5 could be used for pipe up to 10 inches; SDR 26 for pipe up to 14 inches; SDR 21 for pipe up to 22 inches and SDR 17 for the next larger diameter pipe.

The deflections were calculated from the modified Spangler formula, which is the currently best documented and best known design theory for the deflection of a cylindrical horizontal pipe under earth load. The formula is:

$$y = \frac{LKW'}{\frac{2E}{3(SDR - 1)^3 + 0.061 E'}}$$

where y = vertical deflection of pipe in inches

L = deflection lag factor (1.50 for polyethylene)

K = bedding constant (conservatively 0.10 though a value of .083 is specified by good backfill practices)

W' = earth load on pipe in pounds/linear inch (W' = W/12)

E = modulus of elasticity for polyethylene, psi

E' = modulus of soil reaction, psi

The values of 1.50 for the deflection lag factor and 0.10 for the bedding constant come from the WPCF Manual of Practice No. 9 as do the values of the compacted soil moduli. The value of 200 psi is based on our search of the literature. If the soil is compacted to ASTM D-2321 recommended practices, the bedding angle would be 180° for a constant of 0.083. The long term modulus of elasticity of the polyethylene pipe is 30,000 psi from extensive laboratory testing. Since tests show that the deflection of buried polyethylene pipe stops after one year, (the time necessary for soil consolidation to be completed), the use of the 50 year 30,000 psi modulus is very conservative.

Chemical Resistance of Nipak Polyethylene Pipe

TABLE 24

CHEMICAL	75 F	100 F	125 F	150 F	175 F
Acetic acid 60%				
Acetic acid glacial				
Acetone				
Aromatic acids				
Acrylonitrile				
Adipic acid				
Allyl alcohol				
Alums				
Aluminum chloride				
Aluminum fluoride				
Aluminum sulfate				
Ammonia				
Ammonium acetate				
Ammonium carbonate				
Ammonium chloride				
Ammonium fluoride				
Ammonium hydroxide				
Ammonium nitrate				
Ammonium phosphate				
Ammonium sulfate				
Ammonium sulfide				
Amyl acetate				
Amyl alcohol				
Aniline				
Antifreeze				
Antimony chloride				
Arsenic acid				
Barium carbonate				
Barium chloride				
Barium hydroxide				
Barium sulfate				
Barium sulfide				

CHEMICAL	75°F	100°F	125°F	150 F	175 F
Battery acid					
Beer					
Beeswax					
Benzoic acid				
Borax					
Boric acid				
Brine					
Bulane gas				
Butanediol				
Butanol				
Butyl acetate					
Butyl glycol				
Butyric acid					
Calcium carbonate				
Calcium chlorate				
Calcium chloride				
Calcium hydroxide				
Calcium hypochlorite solution				
Calcium nitrate				
Calcium sulfate				
Camphor				
Carbon dioxide					
Carbon monoxide				
Carbonic acid				
Caustic potash					
Caustic soda					
Chloroacetic acid				
Chrome alum				
Chromic acid				
Chromic and sulfuric acid				
Citric acid				
Coal gas (benzene free)				
Coconut oil				
Copper chloride				
Copper cyanide				
Copper fluoride				
Copper nitrate				

..... Acceptable
 Conditional depending on
 operating pressures

TABLE 24 continued

CHEMICAL	75 F	100 F	125 F	150 F	175 F
Corn oil				
Cottonseed oil				
Creosote				
Cresol				
Cyclohexane				
Cyclohexanol				
Cyclohexanone				
Decalin				
Detergents, synthetic				
Developers, photographic				
Dextrin				
Dextrose				
Dibutyl ether				
Dibutyl phthalate				
Dichloroacetic acid				
Diesel oil				
Diethylether				
Diethylene glycol				
Dioxane				
Emulsions, photographic				
Esters, aliphatic				
Ethanol				
Ether				
Ethyl acetate				
Ethylene glycol				
Ferric chloride				
Ferric nitrate				
Ferric sulfate				
Ferrous chloride				
Ferrous sulfate				
Film solutions				
Fluoboric acid				
Fluosilicic acid				
Formaldehyde				
Formic acid				

CHEMICAL	75 F	100 F	125 F	150 F	175 F
Fruit juices				
Fuel oil				
Gasoline				
Gelatin				
Glucose				
Glycerine				
Glycol				
Heptane				
Hexane				
Hexanol				
Hydrobromic acid				
Hydrocyanic acid				
Hydrochloric acid				
Hydrofluoric acid 40%				
Hydrofluoric acid 60%				
Hydrogen				
Hydrogen peroxide 30%				
Hydrogen peroxide 90%				
Hydrogen sulfide				
Hypochlorous acid				
Iodine (alcohol solution)				
Isopropanol				
Isopropyl ether				
Lactic acid				
Lead acetate				
Linseed oil				
Magnesium carbonate				
Magnesium chloride				
Magnesium hydroxide				
Magnesium nitrate				
Magnesium sulfate				
Maleic acid				
Menthol				
Mercuric chloride				
Mercuric cyanide				
Mercurous nitrate				

— Acceptable
 Conditional depending
 on pressure

TABLE 24 continued

CHEMICAL	75°F	100°F	125°F	150°F	175°F
Mercury				
Methanol				
Milk				
Mineral oil				
Molasses				
Naphtha				
Naphthalene				
Nickel chloride				
Nickel nitrate				
Nickel sulfate				
Nitric acid 0-30%				
Nitric acid 30-50%				
Nitric acid 50-70%				
Nitrobenzene				
Nitrotoluene				
Oils and fats				
Oleic acid				
Orthophosphoric acid 50%				
Orthophosphoric acid 85%				
Oxalic acid				
Oxygen				
Ozone				
Paraffin oil				
Perchloric acid 20%				
Perchloric acid 50%				
Perchloric acid 70%				
Petroleum				
Petroleum ether				
Phenol				
Phosphates				
Phosphoric acid				
Phosphorous oxychloride				
Phosphorus pentoxide				
Phosphorus trichloride				
Photographic solutions				
Phthalic acid				
Picric acid				

CHEMICAL	75°F	100°F	125°F	150°F	175°F
Potash				
Potassium borate				
Potassium bromate				
Potassium bromide				
Potassium carbonate				
Potassium chlorate				
Potassium chloride				
Potassium chromate				
Potassium cyanide				
Potassium dichromate				
Potassium ferricyanide				
Potassium ferrocyanide				
Potassium fluoride				
Potassium hydroxide				
Potassium hypochlorite				
Potassium nitrate				
Potassium perborate				
Potassium perchlorate				
Potassium permanganate, 20%				
Potassium persulfate				
Potassium sulfate				
Potassium sulfide				
Propyl alcohol				
Propylene glycol				
Prussic acid				
Salicylic acid				
Sea water				
Selenic acid				
Silicic acid				
Silicone oil				
Silver acetate				
Silver cyanide				
Silver nitrate				
Soap solutions				
Sodium acetate				
Sodium benzoate				
Sodium bicarbonate				
Sodium bisulfate				
Sodium bisulfite				
Sodium borate				

..... Acceptable
 Conditional depending on
 operating pressures



TABLE 24 continued

CHEMICAL	75°F	100°F	125°F	150°F	175°F
Sodium bromide				
Sodium carbonate				
Sodium chlorate				
Sodium chloride				
Sodium chlorite 50%				
Sodium cyanide				
Sodium ferricyanide				
Sodium ferrocyanide				
Sodium fluoride				
Sodium hydroxide				
Sodium hypochlorite				
Sodium nitrate				
Sodium nitrite				
Sodium sulfate				
Sodium sulfide				
Sodium thiosulfate				
Stannic chloride				
Stannous chloride				
Starch				
Stearic acid				
Sulfur dioxide				
Sulfuric acid 50%				
Sulfuric acid 70%				
Sulfuric acid 80%				
Sulfuric acid 98%				
Sulfurous acid				
Tannic acid				
Tartaric acid				
Transformer oil				
Trichloroacetic acid				
Turpentine				
Urea				
Urine				
Vinegar				
Wines				
Yeast				
Zinc carbonate				
Zinc chloride				
Zinc oxide				
Zinc sulfate				

TABLE 25
NON Conveyable Chemicals in Polyethylene Pipe

Aqua Regia
Bromine, gas
Bromine, liquid
Carbon disulfide
Carbon tetrachloride
Chlorine, gas
Chloroform
Fluorine
Nitric acid, above 70% conc.
Ozone
Sulfuric acid, fuming
Sulfur trioxide
Thionyl chloride
Toluene
Trichloroethylene
Xylene

..... Acceptable
.. onal ling o

THE UNIVERSITY OF TEXAS AT AUSTIN

SYMBOL IDENTIFICATION

F - Autocatalytic
X - Unknown

product description

CONTINUED

Reducer/Cleaner: XYLOL, R2 K 4

Shelf Life: 36 months (unopened)

Packaging (weight/gal.): 1 & 5 gal. containers;
12.5# ± 1 lbs./gal.

Shipping Weight: 1 gal.—13.3 ± 1 lbs.; 5 gal.—
66.2 ± 1 lbs.

ANALYSIS:

Pigment by weight: 41.4%

Red Lead	19.4%
Natural Iron Oxide	6.9%
Calcium Carbonate	2.1%
Silicates	13.0%
Tinting Pigment Present	

Vehicle by weight: 58.6%

Chlorinated Rubber	11.7%
Aromatic Solvent	31.8%
Chlorinated Waxes	9.9%
Aliphatic Solvent	3.7%
Other	1.5%

TOTAL100.0%

Limitations: HI-BILD Chlorinated Rubber Primer is not resistant to most solvents, animal and vegetable oil and fats common in dairies, packing houses and sewage treatment facilities.

PRECAUTIONS: FLAMMABLE, VAPOR HARMFUL, CONTAINS LEAD.

Surface Preparation and Priming: All surfaces must be dry and free of oil, grease, dirt, rust or other surface contamination.

Galvanized Iron and Aluminum: Not applicable—see Data Page E-14.

Masonry: Not applicable—see Data Page E-14.

Steel/Iron: Minimum surface preparation is Power Tool Cleaning per SSPC-SP 3-63. For severe exposure or immersion service, blast steel to White Metal Blast per SSPC-SP 5-63. Prime with HI-BILD Chlorinated Rubber Primer the same day and follow with the recommended number of topcoats.

Previously Painted Surfaces: (Not for Immersion) HI-BILD Chlorinated Rubber Primer is not recommended for application over other prime coats or enamels unless they are dried and hardened. If lifting occurs (test a small area), the old paint must be removed or apply a coat of KEM KROMIK® Metal Primer, B50 N 2 or B50 W 1 as a barrier coat.

Application: Apply HI-BILD Chlorinated Rubber Primer directly to all properly prepared iron and steel surfaces.

Mixing and Application: Mix paint thoroughly by boxing and stirring. May be applied by conventional or airless spray. Brush application should be limited to small areas. Be sure to coat thoroughly all welds, corners, etc. Apply at temperatures above 40°F. and relative humidity of less than 85%. Substrate temperatures must be 5°F. above dew point.

Equipment

Brush (small areas only):

Reduce with up to 1 pint XYLOL per gallon if necessary.

Conventional Spray:

Air Supply	80 psi at nozzle, fluid pressure 15 psi
Gun	DeVilbiss JGA 502
Cap	704 Cap, E Tip

Reduction Up to 1 pt./gal. XYLOL, R2 K 4

Airless Spray:

Pump (Minimum) SHERWIN-WILLIAMS
Super Stinger®

Fluid Pressure 2000 psi

Strainer 60 mesh

Tip015

Reduction If necessary up to
1 pt./gal XYLOL, R2 K 4

Cleanup Information: Clean equipment with XYLOL, R2 K 4 following suppliers safety recommendations.

HI-MIL SHER-TAR™ EPOXY ENAMEL

Part A, B69 B 40

Part B, B60 V 40

PRODUCT DESCRIPTION

A one coat, high build polyamide cured coal tar epoxy enamel.

Uses:

- Heavy duty structural protection.
- Nonpotable water tank and pipe coating
- Liner for sewage treatment tanks and equipment
- Use one coat where 2 coats of standard coal tar are normally specified
- Concrete and steel structures. No primer or topcoat required
- Protection against splash and spillage of a wide variety of chemicals
- Hi-Mil Sher-Tar is recommended for:

penstocks	dam gates
sewage treatment equipment	underground tanks
offshore rigs	plating operations
canal linings	paper mills
chemical plants	salt and fresh water
tidal and splash zones	crude oil storage

Performance Information:

Physical Properties:

- Abrasion resistance 483 mg. (ASTM D4060, CS17 Wheel, 1000 cycles, 1 kg. Taber Abraser)
- Flexibility passes (ASTM D1737, 180° bend, 1/4" mandrel)
- Pencil Hardness >8H (ASTM D3363)
- Elcometer adhesion >350 psi
- Dry Heat Resistance 325°F. (ASTM D2485)
- Wet Heat Resistance 140°F.
- Direct impact >80 in. lbs. (ASTM G14)
- Moisture condensation resistance, 100°F., 1000 hours No failure (ASTM D1735)
- Salt Fog resistance, 1000 hours Excellent (ASTM B117)
- Thermal shock, 250 cycles Excellent (ASTM D1211)
- Meets performance requirements of DOD-P-23236A, (Replaces MIL-P-23236) Type 1, Class 2

Chemical Resistance Guide (ANSI N5.12): Consult your Sherwin-Williams representative for specific application and performance recommendations.

Immersion Resistance:

- Aliphatic hydrocarbon solvents, gasoline, kerosene, fuel oil, sour crude oil
- Lubricating oils, cutting oil, animal and vegetable oils and fats
- Alkalies
- Fresh water and sea water

Resistance to Fumes, Splash and Spillage:

- Weak solutions of mineral and organic acids: SEVERE
- Aromatic hydrocarbon solvents: MODERATE
- Glycol ethers, alcohols, selected hydrocarbon solvents, formaldehyde: SEVERE

CHARACTERISTICS

Finish: Semi-Gloss

Color: Black

Spreading Rate: 55 sq. ft. per gal.

(theoretical—no loss*): @ 28 mils wet

*Allow for application losses and surface irregularities when determining working requirements.

Recommended: 28 mils wet/coat

Film Thickness (spray): 20 mils dry/coat

Spreading Rate Coverage@ 1.0 mil dry (theoretical, calculated): 1140 sq. ft. per gal.

Volume Solids: 71% ± 2%

Weight Solids: 80% ± 2%

Application Conditions: Temperature (air surface, material): 55°F. minimum, 100°F. maximum.

Relative Humidity: 90% maximum

Substrate Temperature: 5°F. above dew point

Drying Schedule (temperature dependent) @ 77° & 50% RH @ 28 mils wet: To Touch: 8-10 hours. To Handle: 48 hours. To Recoat: 18 hours min.

Requires minimum 7-10 days cure before placing in service.

Pot Life: @ 70°F.: 4 hours., @ 100°F.: 1 hour

Curing Mechanism: Crosslink polymerization

Flash Point (catalyzed), Pensky-Martens closed cup): 110°F.

Reducer/Cleaner: Reducer #54, R7 K 54

Shelf Life: Minimum 12 months (unopened)

Packaging:

Part A: 3 gal. per 5 gal. pail

Part B: 1 gal. can.

Weight/Gal. (catalyzed): 10.4 ± 1 lbs./gal.

Shipping Weight: 46.5 lbs./4 gal.

Application: Conventional and airless spray

ANALYSIS (MIXED):

Pigment by weight: 24%

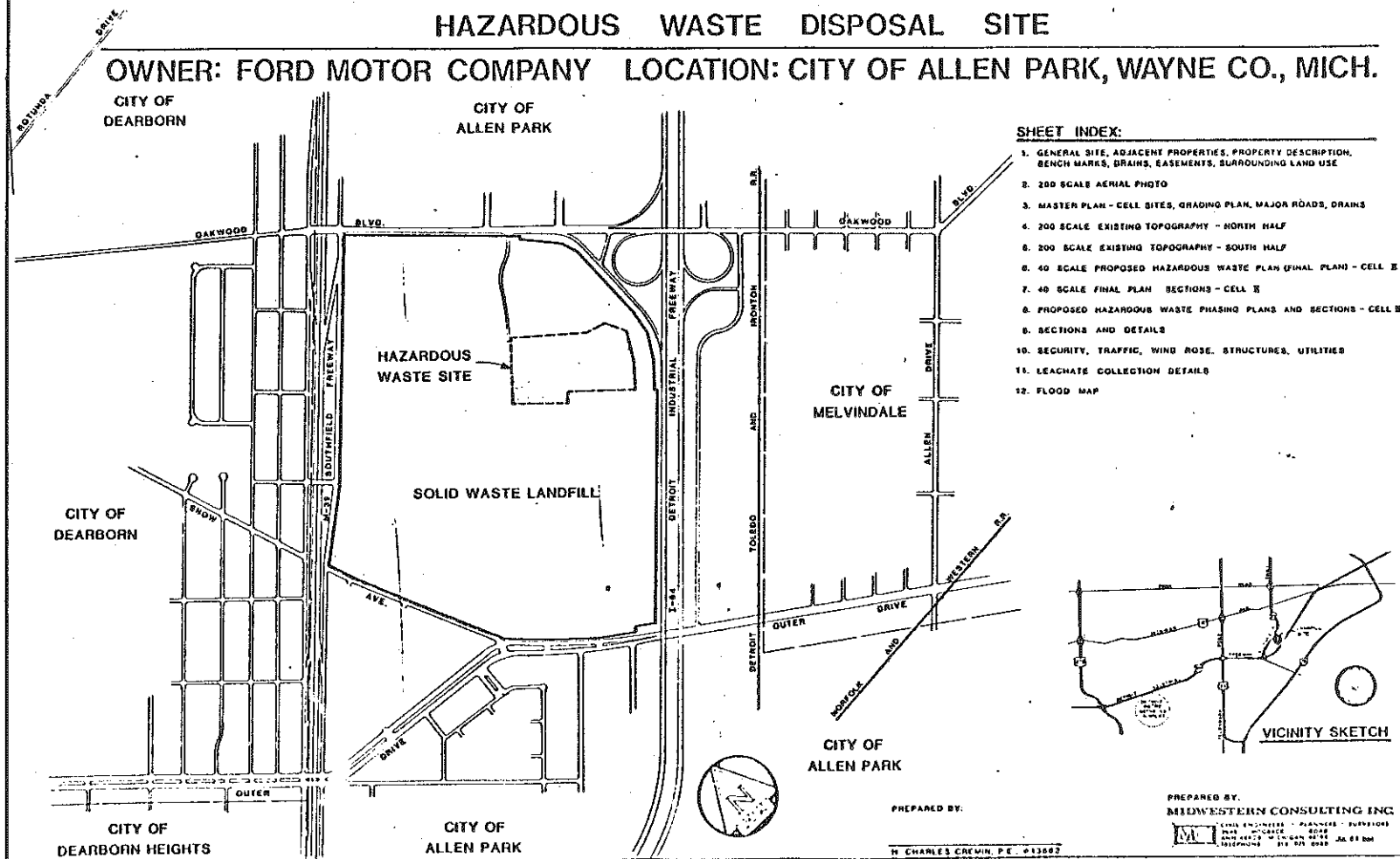
Silicates	21%
Silica	3%
Vehicle by weight: 76%	
Polyamide Resin	11%
Epoxy Resin	14%
Coal Tar	27%
Lecithin	2%
Aromatic Hydrocarbon	19%
Alcohols	3%
Totals	100%

PRECAUTIONS: B69B40, COMBUSTIBLE
B60V40, COMBUSTIBLE—VAPOR HARMFUL

ALLEN PARK CLAY MINE LANDFILL

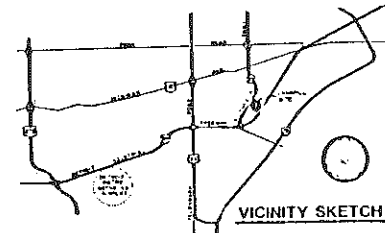
HAZARDOUS WASTE DISPOSAL SITE

OWNER: FORD MOTOR COMPANY LOCATION: CITY OF ALLEN PARK, WAYNE CO., MICH.



SHEET INDEX:

1. GENERAL SITE, ADJACENT PROPERTIES, PROPERTY DESCRIPTION, BENCH MARKS, DRAINS, EASEMENTS, SURROUNDING LAND USE
2. 200 SCALE AERIAL PHOTO
3. MASTER PLAN - CELL SITES, GRADING PLAN, MAJOR ROADS, DRAINS
4. 200 SCALE EXISTING TOPOGRAPHY - NORTH HALF
5. 200 SCALE EXISTING TOPOGRAPHY - SOUTH HALF
6. 40 SCALE PROPOSED HAZARDOUS WASTE PLAN (FINAL PLAN) - CELL I
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9. SECTIONS AND DETAILS
10. SECURITY, TRAFFIC, WIND ROSE, STRUCTURES, UTILITIES
11. LEACHATE COLLECTION DETAILS
12. FLOOD MAP

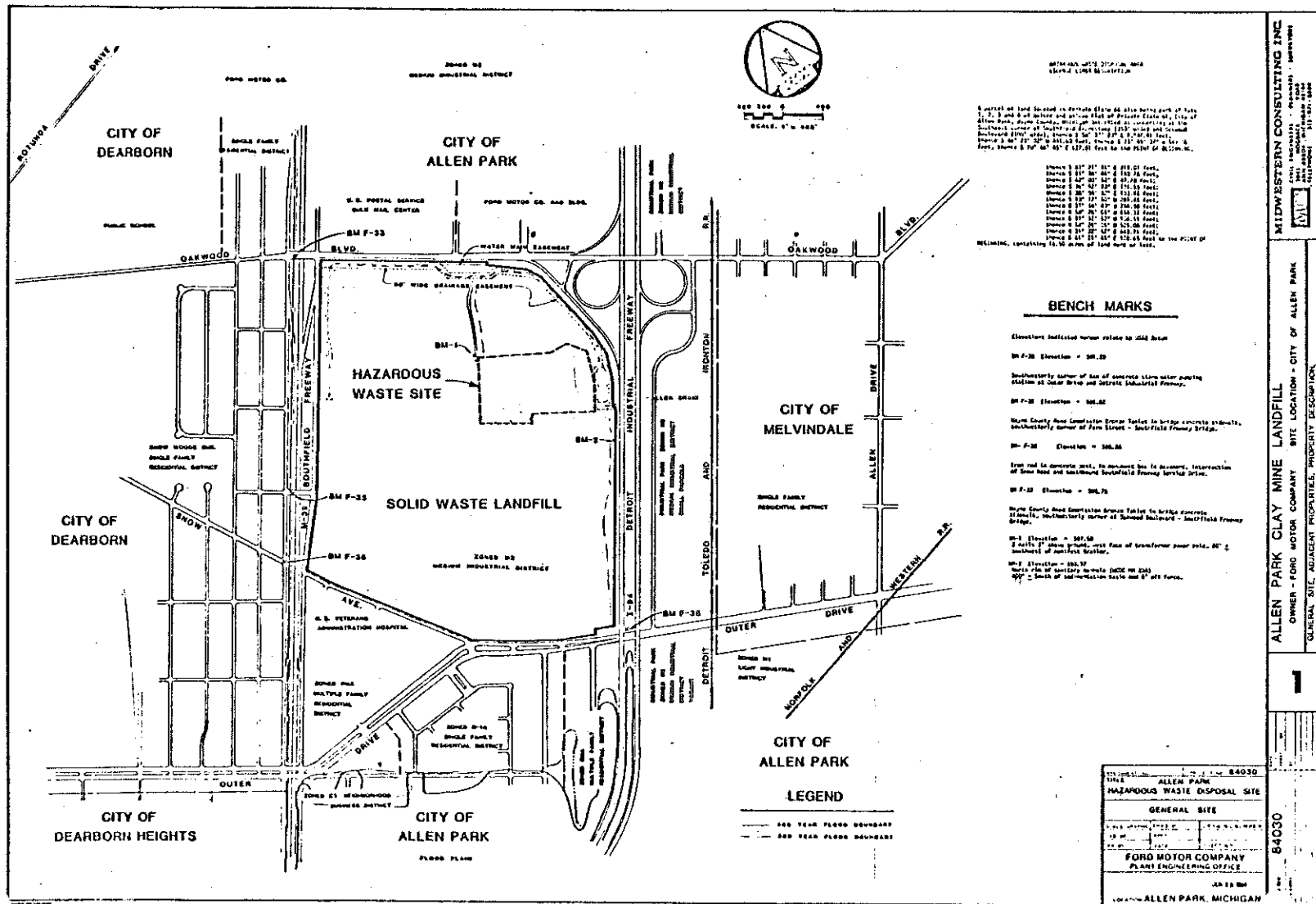


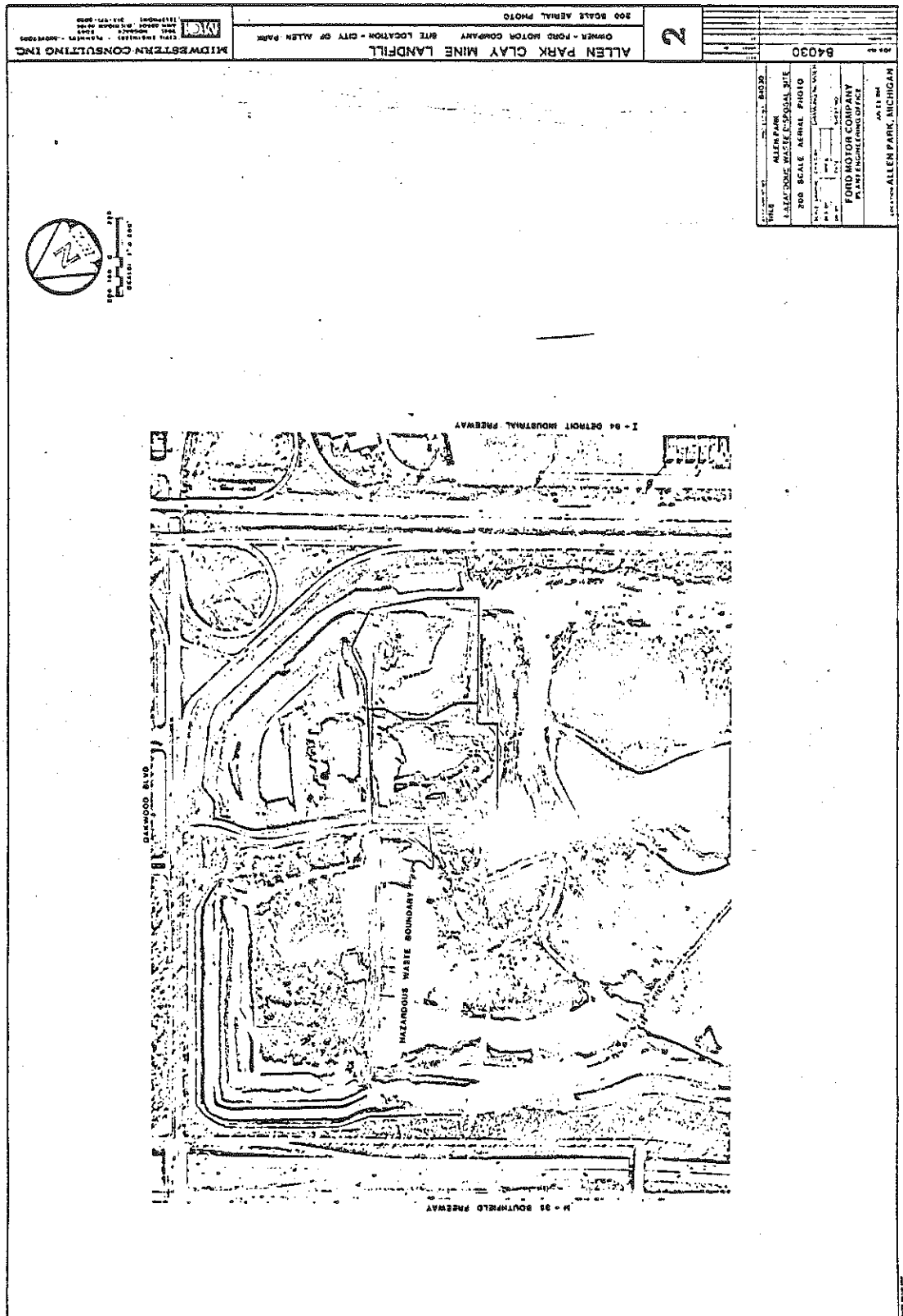
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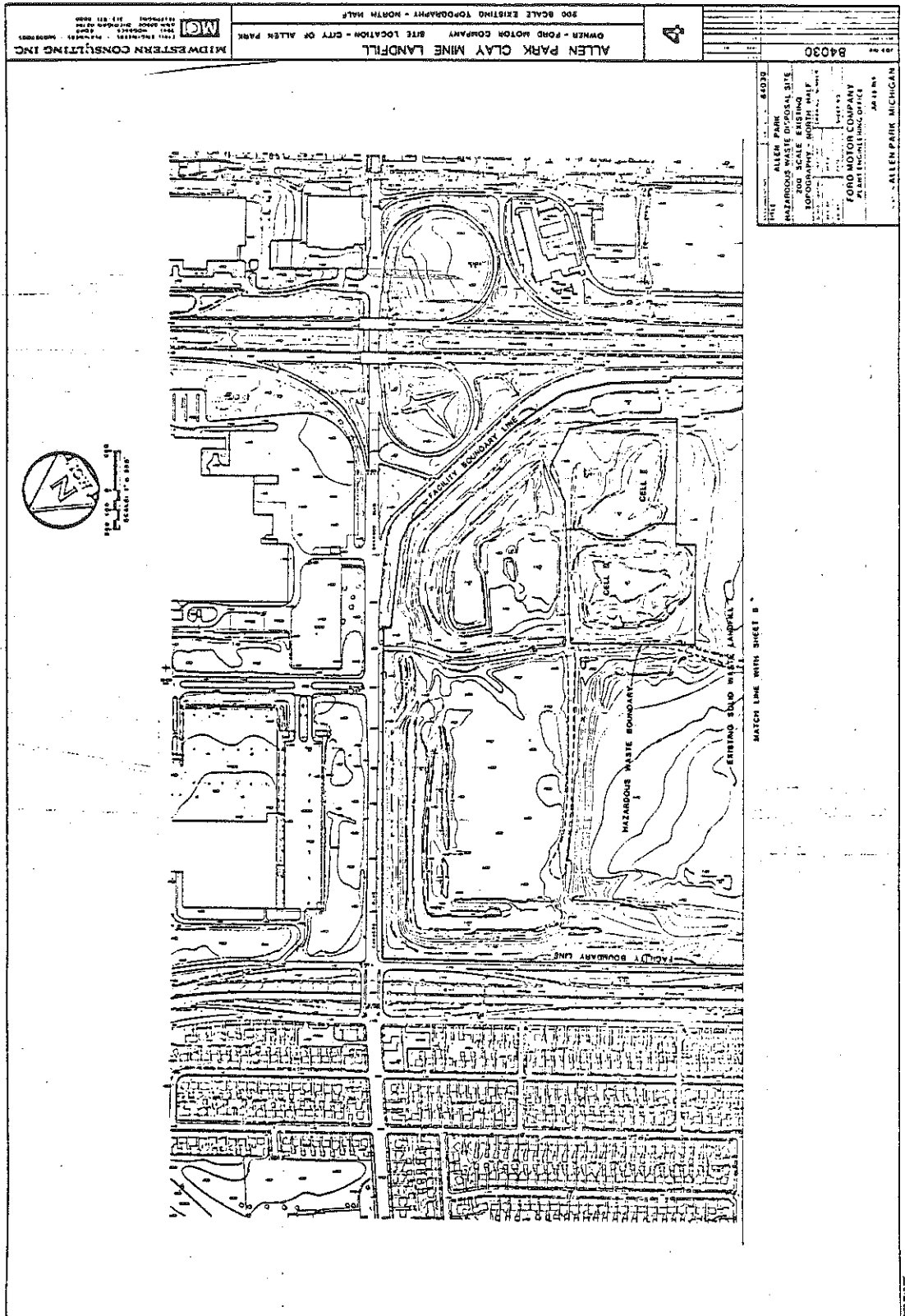
PREPARED BY:
MIDWESTERN CONSULTING INC.

CIVIL ENGINEERS - PLANNERS - SURVEYORS
P.O. BOX 100000 - DETROIT, MI 48208
TELEPHONE 810 200 0000

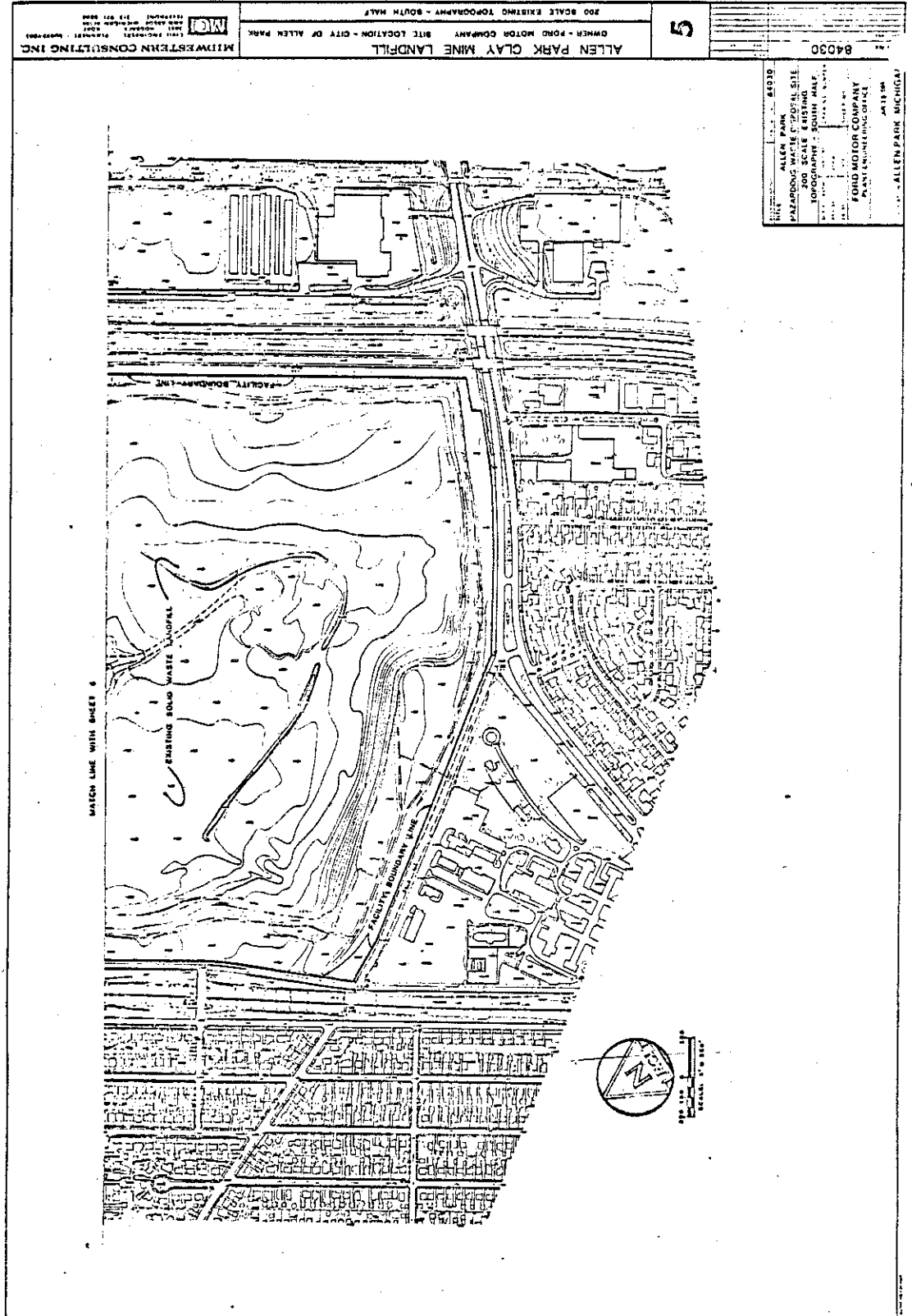
H. CHARLES CREMIN, P.E. #13882



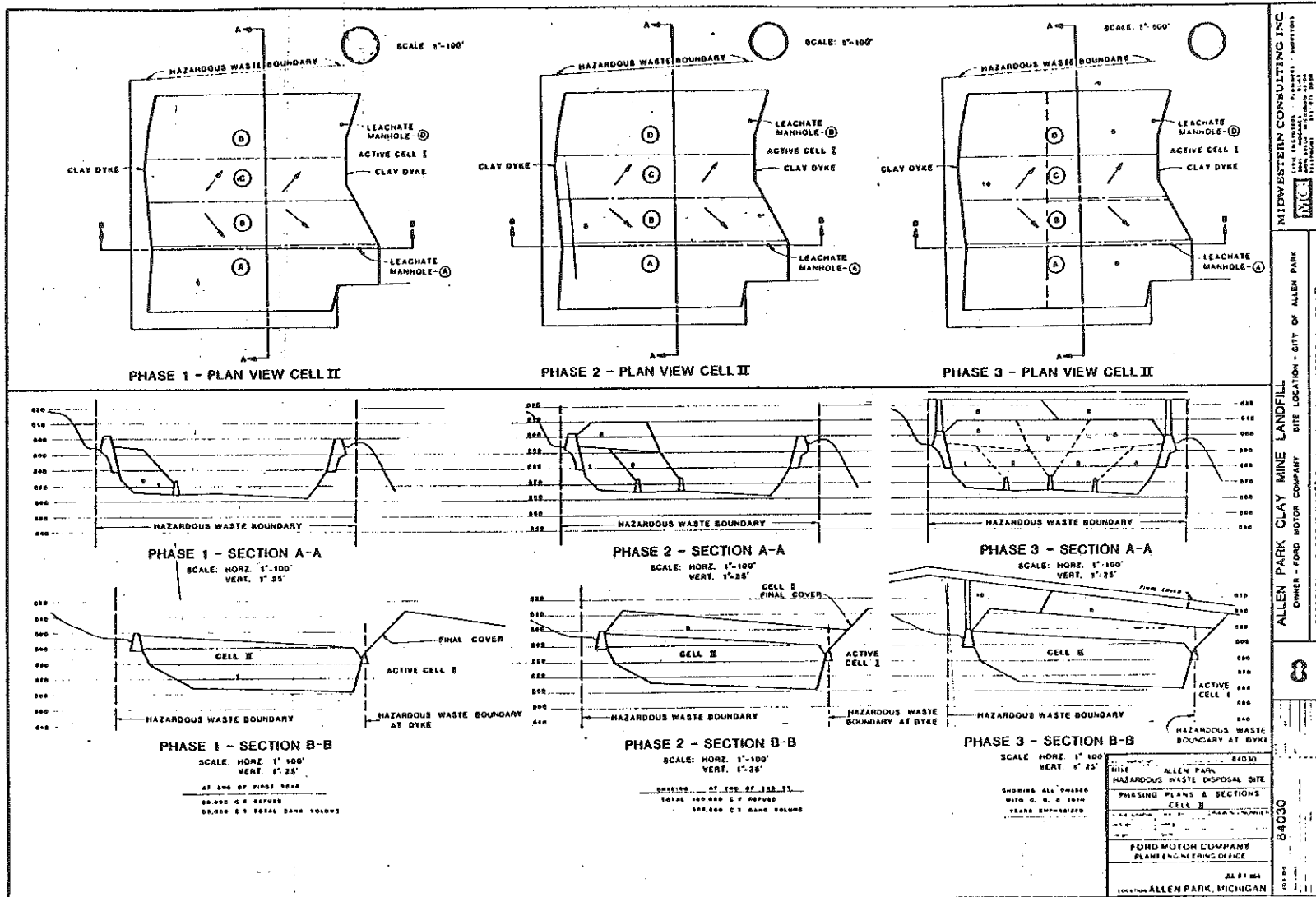




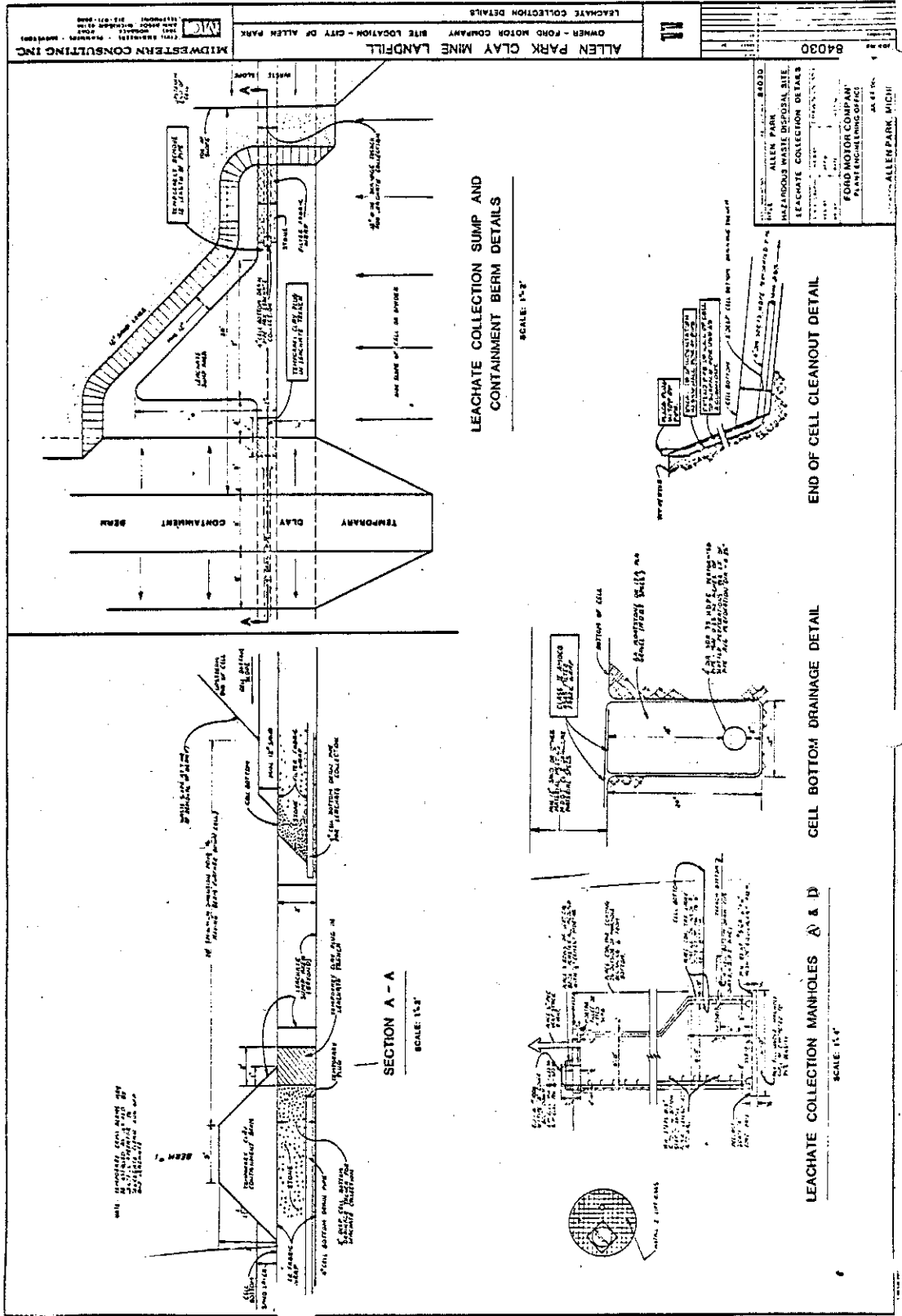
DATE	10/10/90
SHEET	4
PROJECT	ALLEN PARK HAZARDOUS WASTE DISPOSAL SITE
SCALE	200 SCALE EXISTING
DATE	10/10/90
BY	J. J. JONES
CHECKED	J. J. JONES
APPROVED	J. J. JONES
OWNER	FORD MOTOR COMPANY
LOCATION	ALLEN PARK, MICHIGAN











D-6f

Run-On Control Systems 40 CFR 270.21 (b) (2)

The Facility Standard states that to minimize leachate generation:

"The owner or operator must design, construct, operate, and maintain a run-on control system capable of preventing flow onto the active portion of the landfill during peak discharge from at least a 25 year storm."

D-6f (1) Calculation of Peak Flow

1. Description of Hydrologic method used to estimate peak flow rates.

This will be done using methods as outlined in reference section 2.4.3 par (1) (a) and (b).

2. Data and Input parameters.

- Soil classification determined from available soil boring data.
- Runoff areas and slopes determined from available topographic maps.
- Type of ground cover determined from field observation.
- On-site drainage data taken from present landfill plans..

3. Determine Peak Flow Rate 25 yr. storm

Using US Weather Bureau Technical Paper No. 40-25 yr. 24 hr. rainfall is 4.0 inches for this area.

Using US Soil Conservation Service Engineering Handbook procedure:

Ditch Along Existing Haul Road

- Type "B" Soil
- Slopes-Moderate (3-8%)
- Most offsite area would be classed as "cultivated"
- From the above a runoff curve number (CN) of 80 would be conservative
- Drainage area tributary to the most downstream ditch point at NW corner of Cell II = 26 ac.
- Using Exhibit 2-8 sheet 12 of 21
Peak Discharge = 30 c.f.s.
- Using Exhibit 2-7
Runoff Depth = 2.04 inches.

Typical Secondary Ditch Drainage Calculation (along
N & S sides of Cell II)

- Type "B" Soil
- Slopes moderate (3-8%)
- Surface Character-cultivated
- Use Runoff Curve (CN) of 80
- Drainage area tributary to the largest of these secondary ditches = 4.4 ac.
- Using Exhibit 2-8 Sheet 12 of 21
Peak Discharge = 11 cfs.
- Using Exhibit 2-7
Runoff Depth = 2.04 inches

D-6f (2) Design and Performance

The basic Run-On control facility is the drainage ditches that run along the north west and south sides of Cell II. As the cell is prepared for operation, a clay dyke is constructed around the cell, through the upper sand formation and extending 5 to 7 ft. above normal ground surface. This dyke will prevent run-on from entering Cell II from areas outside the cell.

The drainage ditches will be checked for adequate size and capacity.

Ditch Along Existing Haul Road

bottom width = 3 ft.
sides slopes 1:2
ditch bottom slope 0.24%
"N" factor = 0.03
design Q = 30 c.f.s.
Formulas $A = \frac{Q}{V}$

$$A = sd^2 + wd$$

$$c = \frac{1.49}{N} (d)^{1/6}$$

$$R = \frac{A}{wp}$$

$$V = c RS$$

$$A = \frac{30 \text{ c.f.s.}}{2.75 \text{ f.p.s.}} = 10.9 \text{ sq. ft.}$$

$$10.9 \text{ sq. ft.} = 2 d^2 + 3d \quad d = 1.7 \text{ ft.}$$

$$c = \frac{1.49}{0.03} (1.7)^{\leftarrow (.167)} = 54.3$$

$$R = \frac{10.9}{10.6} = 1.03$$

$$V = 54.3 \sqrt{1.03 \times .0024} = 2.70 \text{ fps (OK)}$$

Since ditch bottom is 6 ft. below top of dyke, there is no problem with this ditch handling run-on with no overflow into active areas.

$$\text{Minimum freeboard} = 6.0' - 1.7' = 4.3 \text{ ft.}$$

Secondary ditches

Bottom width = 1 ft.
Side slope 1:3
Ditch bottom slope = 0.3%
"N" factor = 0.03
Design Q = 11 cfs.
Same formulas as Major ditch

$$A = \frac{11 \text{ cfs.}}{2.0 \text{ fps.}} = 5.5 \text{ sq. ft.}$$

$$5.5 \text{ sq. ft.} = 3 d^2 + 1 d \quad d = 1.2 \text{ ft.}$$

$$c = \frac{1.49}{0.3} (1.2)^{.167} \quad c = 51.2$$

$$R = \frac{5.5}{8.7} = 0.63$$

$$V = 51.2 \sqrt{0.63 \times .003} = 2.2 \text{ f.p.s. (OK)}$$

Since the secondary ditches are all 5 ft. deep and the point analyzed is the worst point for volume of runoff to be handled, therefore, there will be no problem with these ditches handling run-on with no overflow into active areas.

$$\text{Minimum freeboard} = 5.0' - 1.2' = 3.8 \text{ ft.}$$

Structural Design

All Run-on control conveyances are in the form of open ditches constructed of available on-site CL or CH classification clay soil material. This material has been used on-site for dyke construction and cover material for several years, and has proven to be structurally stable, and easily compacted to specification densities. Ditch velocities for the various design conditions are very low and non-erosive. Very generous freeboard depths are also available in all ditches.

D-6f (3)

Construction

The ditch along the west side of Cell II adjacent to the existing haul road is already existing.

The next step in the major ditch procedure is the excavation of the sand formation and construction of the clay cut off walls extending from the existing clay formation up to plan grades. This cut off wall forms one side of the ultimate ditch section, and provides an engineered, clay barrier between the ditch and Cell II, preventing both surface overflow and underground, intrusion into the cell.

These two type of ditches, in combination, protect the entire perimeter of the Cell from Run-on from adjacent land areas. The ditch capacities and freeboard calculations are set forth above.

D-6f (4)

Maintenance

The generally low velocities and rates of flow, combined with substantial excess available capacity substantially reduce any expected need for repair, and also reduce the possibility that a failure could result in run-on entering the active areas.

However, all ditches will be inspected on a regular basis, not exceeding 3 month intervals, and any potential failure areas repaired as appropriate. Active landfill areas that are still below ground will be inspected on a weekly basis or after each storm event to see that no failures in the drainage system have occurred.

D-6g Run-Off Control System 40 CFR 270.21(b)(3)

The Facility Standard states that to minimize hazards from run-off of contaminated liquid:

"The owner or operator must design, construct, operate, and maintain a run-off management system to collection and control at least the water volume resulting from a 24-hour, 25-year storm."

D-6g(1) Calculation of Peak Flow

We are concerned here about the portion of the landfill that is in a technically "active" stage at any one time. This is understood to mean all areas where waste has been placed, that have not yet received completed final cover.

This can be broken down into basic situations:

1. Fill surface below normal ground
2. Fill surface above normal ground

The general design concept to be used, will consist of containing as much of the direct active area run-off as possible, in or on the cell, while minimizing the amount of this runoff that is allowed to enter the stored waste. After collection and containment, and after the storm event is over, the runoff will be removed for physical evaluation, and possible treatment prior to discharge. Method of discharge will be determined by the end quality of the runoff.

Runoff Calculation Assumptions:

Formulas and assumptions are the same as used in the Run-on computation:

- Type "B" Soil
- "Moderate slopes (3-8%)
- Surface character "cultivated"
- Use Runoff curve (CN) of 80

Active Area Assumptions:

It is believed reasonable to assume that the maximum "active" area at any given time will not exceed the equivalent of half the overall cell area. This means that at least half of the overall cell area of 7.65 acres would either be unfilled or have intermediate or final cover over it at any given point in time.

D-6g

Run-Off Control System 40 CFR 270.21(b)(3) (Cont'd)

The exposed 3.8 acre waste area can be expected to be either above or below ground at any given point in time. It is also assumed that the below ground area is half exposed waste, with the other half being unfilled cell. This then results in typical design analysis area increments of 1.9 acres at the cell bottom, and 3.8 acres in the above ground condition.

Peak Runoff Calculation

Under assumptions above, the "active" area was broken into 1.8 acre and 3.6 acre increments for analysis. Runoff volume in a 25 year 24 hour storm as taken from US Soil Conservation Service Engineering Manual exhibit 2-7 is 2.04 inches of runoff depth for a CN of 80.

$$\text{Runoff Volume} = 1.8 \text{ ac.} \times 43,560 \times \frac{2.04}{12} = 13,330 \text{ cu.ft.}$$

$$\text{Runoff Volume} = 3.6 \text{ ac.} \times 43,560 \times \frac{2.04}{12} = 26,660 \text{ cu.ft.}$$

This is the volume of runoff in the design storm condition; lesser storms than 25 yr. frequency will generate less runoff.

D-6g(2) Design and Performance

The 1.9 acres in unfilled cell bottom area has its runoff provided for through isolation from the portion containing waste by a series of cross dykes in the cell. The runoff in the "clean" end of the cell is collected in the low end of the cell and pumped out to the natural drainage system.

The area of exposed waste which is below ground, will not have any separate, dedicated runoff collection system. Several potential temporary means were considered, but discarded due to practical difficulties in maintaining them during the waste placement operation. What is proposed for this stage of landfill operation is to allow the runoff falling directly on the active work area to infiltrate into the waste and be pumped out of either the temporary leachate sumps on the waste side of the bottom cross dykes, or when the bottom is filled, to be pumped out of the permanent leachate collection manhole. It is felt that this is a more practical way of handling runoff during this stage of the landfill operation, and will result in some buffering of leachate volumes to be handled. While this may result in higher contaminant levels in the leachate, it is felt that this material must be handled as leachate anyway. Emphasis will be placed on keeping the exposed waste working face as

small as possible, getting above ground as soon as possible, and placing intermediate or final cover as soon as possible. All of these will tend to reduce the leachate generated while the landfill is in a below ground condition. It is recognized that this is the most critical period for control of leachate, and it is our opinion that time of exposure reduction is the most effective way to manage leachate generation at this stage.

The exposed area of 3.8 acres in which filling is complete and the fabric liner placed, but which has not yet received final clay cover, is the next most critical runoff collection area. In this case, final cover will be placed from the high area toward the low area of the cell, with the low area behind the Cell I final cover, and on top of the fabric cover liner to be used for collection and temporary storage of runoff. The size of this required system will be calculated. The final cover drain pipes will have been installed through Cell I above the fabric liner; they would have to be temporarily plugged.

This 3.8 acre area is approximately 300 ft. wide along the west side of Cell I. Assuming the surface slope matches the final cover grade of 3.5%, then the required depth of runoff water at the downslope end to store 26,660 cu.ft. would be 2.4 ft. This is significantly less than the available 4.0 ft.

The area in which final cover is almost complete, represents the least critical runoff area, since runoff from this area has very little chance of being contaminated and the end cover protection system is almost in place. In principle this can be handled in similar fashion as above, but as final cover is completed at the low end of the cover (next to Cell I) then the runoff collection system would be phased out. Any water seeping through the clay cap will be collected on the fabric top liner and directed to the perforated pipe drainage system along the downstream slope of Cell II.

D-6g(3) Construction

Most of the construction elements outlined above are part of the normal required construction of the landfill, and are covered elsewhere in this report, or in the accompanying plans.

D-6g(4) Maintenance

Since most construction elements are part of normal landfill construction, their maintenance is part of that activity as well. Temporary cross berms will be inspected weekly or after each storm event to check for weak or failed areas, which if found will be repaired as soon as weather permits. Temporary surface containment berms will be inspected on the same schedule. Drain pipes will be checked on the same schedule to see that no failure, silting in, or other blockage has occurred.

Runoff will be promptly pumped out after each storm event, tested if necessary and appropriately discharged as previously provided for.

The Facility Standard states that:

"Collection and holding facilities (e.g., tanks or basins) associated with run-on and run-off control systems must be emptied or otherwise managed expeditiously after storms to maintain design capacity of the system."

The only collection and holding facility proposed, is for containment of clean runoff in the trench bottom beyond the active face temporary berm, and containment of surface runoff until final cover is completed. Both of these facilities will be pumped dry immediately after each storm event. If there is any question of contamination of any of this runoff, it shall be tested to determine if any treatment is required prior to discharge.

Runoff that is allowed to pass through the active area will be removed from the leachate sump or leachate collection manhole for evaluation and possible treatment prior to discharge to the municipal sanitary sewer system. All non-contaminated runoff will be discharged to the natural drainage course. All contaminated runoff will be handled as leachate and processed through the leachate holding tank, with ultimate discharge to Wayne County's public sanitary sewer manhole #23A.

Ford Allen Park Clay Mine

MID 980568711

Section E Groundwater Monitoring

- E-1 Exemption From Groundwater Protection Requirements 40 CFR 270.14(c),
40 CFR 264.90(b)

A waiver from the Subpart F groundwater monitoring requirements is requested. Specifically, the requested exemption includes all sampling of the artesian aquifer immediately below the in-situ saturated clay liner. Annual static water elevations will be taken for the operating life of the facility to verify the artesian aquifer conditions.

E-1a through e Not Applicable.

- E-1d No Migration 40 CFR 264.90(b)(4)

Refer to Attachment 15 for the demonstration to waive certain groundwater monitoring requirements as provided for under 40 CFR 264.90(b)(4) of the RCRA rules, based on favorable site geology to the aforementioned rules.

Under the conditions stated in this demonstration, there is no potential for migration of liquid from the regulated unit to the uppermost aquifer during the active life of the regulated unit and the post-closure care period. The monitoring of water quality in the artesian aquifer cannot possibly detect leachate migration from the overlying disposal site. Accordingly, the Allen Park Clay Mine Landfill qualifies for the groundwater monitoring waiver set forth under the applicable regulations.

The waiver provision was developed specifically for facility site locations such as the Allen Park Clay Mine based on the following discussion published in the Federal Register.

Fourth, the owner or operator of a regulated unit may be excluded from Subpart F if the Regional Administrator finds that there is no potential for hazardous constituents to migrate from the regulated unit to the uppermost aquifer during the active life of the unit (including the closure period) and the post-closure care period specified under § 264.117. This exclusion is designed for units located in hydrogeologic settings that prevent leachate migration to ground water for very long periods. In such a setting, hazardous waste leachate would simply not be able to

reach ground water during the active life of the unit and the post-closure care period. Where there is a high degree of confidence that such a hydrogeologic setting is present, EPA decided that it would be of little value to require the permittee to implement a detection monitoring program. (Such a program would simply not detect contamination during the active life of the regulated unit plus the post-closure care period.)

Moreover, EPA believes it may be productive to exclude such locations from ground-water monitoring. Such locations are relatively desirable for waste disposal because soils which provide long delays in the arrival of leachate in ground water may also have characteristics that attenuate hazardous constituents. Excluding ground-water monitoring requirements at such locations could encourage the use of such environmentally desirable locations.

Ford Motor CompanyAllen Park Clay Mine Landfill

E.P.A. I.D. No. MID 980568711

Demonstration for Exemption of Subpart F Requirements
Under 40 CFR 264.90 (b) (4)

Demonstration is hereby made to waive certain groundwater monitoring requirements as provided for under 40 CFR 264.90 (b) (4) of the RCRA rules, based on the favorable site geology to the aforementioned rules. Specifically, the requested exemption includes all sampling of the artesian aquifer immediately below the in-situ saturated clay liner.

Site DescriptionDepositional Environment:

The site hydrology is governed by the last glacial period in which the Huron-Erie ice lobe occupied southeast Michigan as shown on Exhibit A. When the ice lobe retreated, a proglacial lake (Lake Maumee) formed, as shown on Exhibits B and C. The site vicinity is located at least 16 miles from the shores of this lake. The clay sediments deposited in the site vicinity reflect this low energy depositional environment. The lacustrine clay is generally 80-120 feet in thickness and has become an effective aquiclude since the recession of the lake. The recharge area for the underlying aquifer is the moraine and outwash complex to the northwest and the underlying Devonian carbonate formations.

Artesian Aquifer:

The confined aquifer is located approximately 70 feet below the existing grade at the Allen Park site and varies in thickness from one to six feet. It exerts an upward hydrostatic pressure on the clay aquiclude equivalent to 80 feet of head. This hydraulic gradient in the upward direction is a counteracting force against those of leachate migration (drag coupling effect and chemico-osmotic diffusion). Under these conditions, there is no potential for migration of liquid from the regulated unit to the uppermost aquifer during the active life of the regulated unit and the post-closure care period. Refer to Exhibit D for a full discussion on leachate migration at the facility.

Subsurface Soil Conditions:

The uniformity of the clay sediments in the Detroit area (Erie-St. Clair Plain) has been documented by the numerous soils exploration and foundation engineering studies required for all of the building and construction projects in the vicinity.

To be site specific, the following documentation has been established:

- 1) Clay mining operations, excavating clay for the manufacture of cement, have encountered more than 45 feet of uniform material over the entire site.
- 2) Seismic work on the cell bottom indicates that the bedrock is between 57 and 70 feet below the cell bottom with uniform material to that depth. Refer to Exhibit E.

- 3) Soil samples taken from the five most recent borings indicate the clays are saturated to the surface from the artesian aquifer. Refer to Exhibit F.
- 4) Soil tests performed (grain size analysis, atterberg limits and permeability) on the clay provided more than adequate uniformity. Refer to Exhibit G.
- 5) The 12 deep borings indicate uniform soil conditions. Refer to Exhibit H.
- 6) The deep monitor wells into the artesian aquifer provide piezometric surface elevations that are consistent with the regional data which conclude that ground surface is below the piezometric surface. Refer to Exhibit H.
- 7) Additional studies, maps, and tests relating to subsurface conditions at the site indicate that subsurface clay is in excess of 25 feet thick with a permeability coefficient which is no greater than 6.0×10^{-8} cm/sec. In addition, the underlying artesian aquifer exerts hydrostatic pressure in an upward direction which precludes the possibility of leakage from the cell into the liner during the active life of the disposal facility. Refer to Exhibit H.
- 8) Additional geological information is provided by W. H. Sherzer, "Geological Report on Wayne County", Publication 17, Geological Series 9, 1913.

Summary:

Under the conditions stated in this demonstration, there is no potential for migration of liquid from the regulated unit to the uppermost aquifer during the active life of the regulated unit and the post-closure care period. The monitoring of water quality in the artesian aquifer cannot possibly detect leachate migration from the overlying disposal site. Accordingly, it is therefore believed that the Allen Park Clay Mine Landfill qualifies for the groundwater monitoring waiver set forth under the applicable regulations.

Prepared by: David S. Miller, Geologist
Mining Properties Department
Rouge Steel Company
(University of Michigan B.S. 1977)

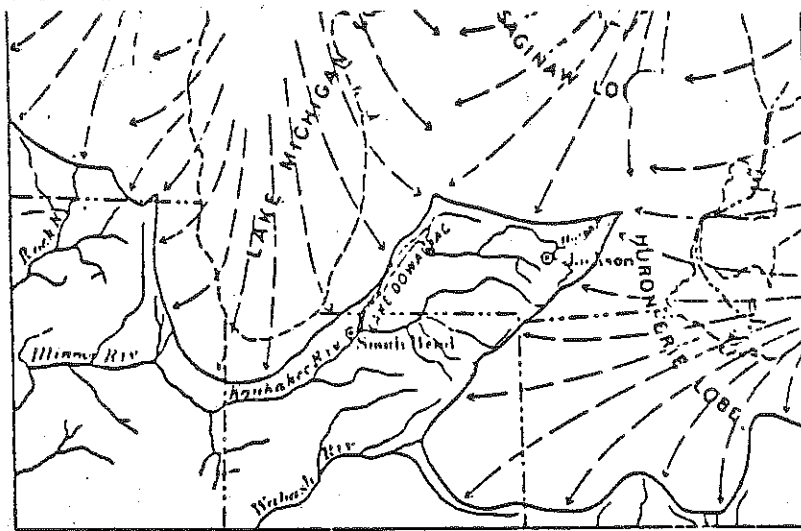


EXHIBIT A

(Map from Frank Leverett)

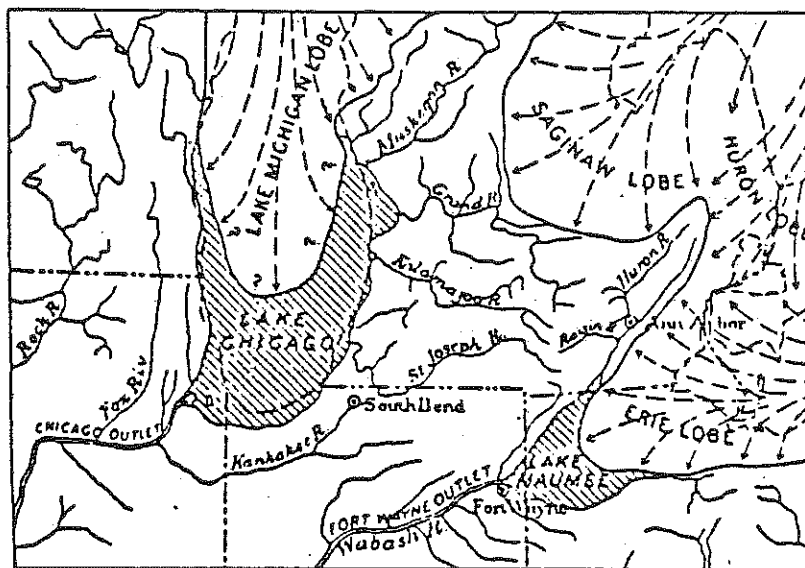


EXHIBIT B

(Map from Frank Leverett)

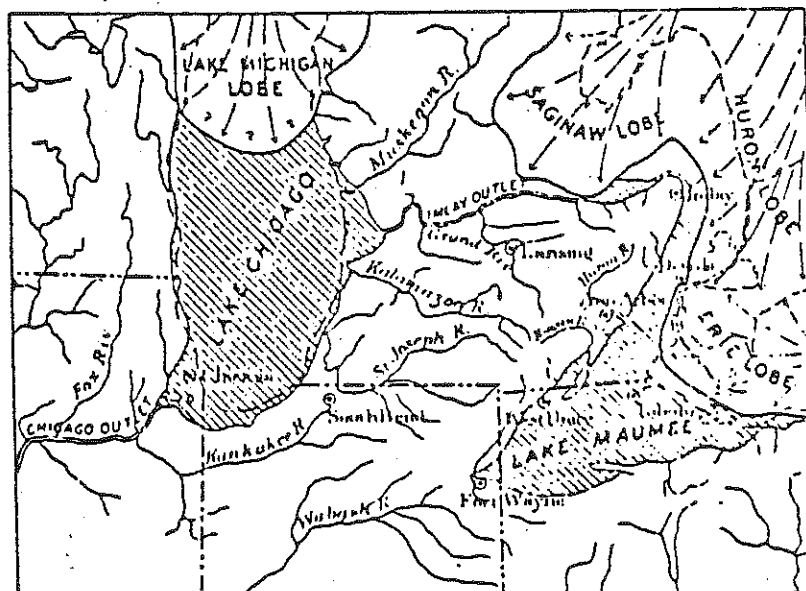


EXHIBIT C

(Map from Frank Leverett)

Report Prepared for:

Wayne Disposal, Inc.

CONTAINMENT INTEGRITY OF ALLEN PARK
CLAY MINE/LANDFILL

by

Donald H. Gray
Professor of Civil Engineering
The University of Michigan

Ann Arbor, Michigan

July 1983

SUMMARY

The possibility of leachate migration downward from the Allen Park Clay Mine/Landfill and contamination of an aquifer beneath were evaluated.

Analyses show that density differences between the leachate and groundwater will not cause a downward migration nor will they lead to a diffusion efflux from the site. A thick, uniform layer of silty clay beneath the site coupled with an upward hydraulic gradient effectively precludes the latter.

Comparison with results of salt water intrusion studies across clay aquitards having similar properties as the clay beneath the Allen Park site show that the solute (salt) will take at least 800 years to migrate across a clay barrier 30 feet thick under chemico-osmotic diffusion alone. A counter (or upward) hydraulic gradient will lengthen this breakthrough time even further.

There are insufficient amounts of organic compounds in the waste to affect the permeability of the clay. The probability of accelerated leachate migration through the underlying clay is not supported by the composition of the wastes and the nature of the clay nor by the findings of leachate permeability studies reported in the technical literature.

Under these circumstances any observed increases in contaminant levels of monitor wells in the aquifer underlying the site could more reasonably come from sources laterally upgradient from the site rather than the clay mine/landfill above the site.

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CONTAINMENT INTEGRITY OF ALLEN PARK CLAY MINE/LANDFILL

I. INTRODUCTION

The Ford Motor Company who operate the Allen Park Clay Mine/Landfill have recently petitioned to discontinue ground water monitoring of an aquifer located approximately 70 feet below existing grade at the site. The landfill is underlain by dense, lacustrine clay which behaves as an aquiclude or aquitard. At least 25 feet or more of residual clay thickness separates the bottom of the landfill from the underlying aquifer. The aquifer is under artesian pressure and exerts an upward hydrostatic pressure on the base of the clay aquitard equivalent to 80 feet of head. A general cross section or profile illustrating these soil and hydrologic conditions at the site is shown in Figure 1.

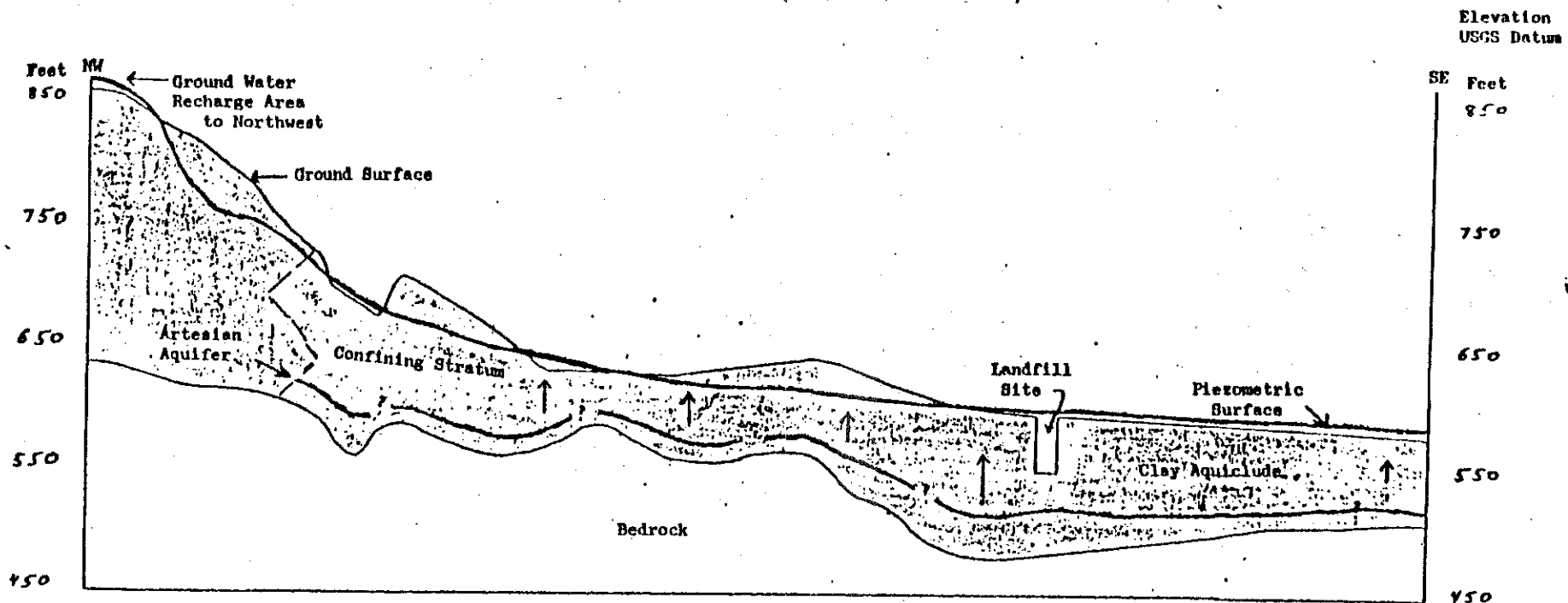
Applicant maintains in his petition for discontinuance (EPA I.D. No. MIT 980568711) that monitoring is not necessary at the site because of a) the dense, uniform clay underlying the site which has a hydraulic permeability no greater than 6×10^{-8} cm/sec and b) the artesian pressure in the underlying aquifer which results in an upward hydraulic gradient across the overlying clay aquitard. Applicant claims that these site conditions will preclude the possibility of leachate migrating downwards out of the landfill and eventually contaminating the aquifer.

In response to this petition, the Wayne County Department of Public Health has raised several questions and concerns (letter from R.N. Ratz, Public Health Engineer, to B. Trethewey, Mining Properties Department, Ford Motor Company, 28 April 1983). The following concerns were raised in the letter:

1. The petition/report fails to address the possibility of leachate migrating down due to differences in densities of the leachate and groundwater.
2. The petition/report does not indicate if there are any organic constituents in the leachate that may increase the clay's permeability and permit downward movement.

The purpose of the present report is to respond to the above stated concerns. Additional information about the geohydrology of the site, about past containment/migration studies, and about the likely nature of the leachate and its effect on clay permeability are evaluated herein to determine the danger of landfill leachate migrating downwards from the site and reaching the underlying aquifer.

NW - SE GENERALIZED CROSS SECTION
METROPOLITAN DETROIT AREA (ERIE - ST. CLAIR PLAIN)



SCALE

Vertical 1" = 100 Feet
Horizontal 1" = 2 Miles

Reference Map

USGS - Mich. Detroit District
Geology by W. H. Sherzer

Figure 1. Generalized cross-section through Allen Park Clay Mine/Landfill showing soil and hydrologic conditions.

II. THE INFLUENCE OF PERMEANT DENSITY ON LEACHATE MIGRATION ACROSS CLAY BARRIERS

A. GENERAL

Permeant density plays a direct and indirect role in flow phenomena in porous media. Permeant density can affect solvent or solution flow rates via its influence on hydraulic conductivity. This influence can be calculated and shown to be minor or insignificant compared to the more likely and important influence of permeant density on solute diffusion.

A newly introduced permeant with a high concentration of dissolved material (e.g., a leachate) will also have a higher density. This high concentration in turn will cause the solute to diffuse through a porous medium to regions of lower concentration. It is this manifestation or aspect of a density increase in the permeant that requires careful scrutiny and analysis. In other words, the role and influence of permeant density are more important to solute diffusion under concentration gradients as opposed to solvent (or solution) convection under hydraulic gradients.

The analyses that follow are offered in support of these claims.

B. INFLUENCE OF PERMEANT DENSITY INCREASE ON HYDRAULIC PERMEABILITY

Both the viscosity and unit weight of a permeant can influence the permeability of a soil to a particular permeant. The hydraulic conductivity is defined in this case as a flow velocity under a unit hydraulic gradient (the usual practice in civil engineering). The influence of permeant density and viscosity can be ascertained explicitly by defining another permeability, i.e., the "intrinsic" or "absolute" permeability

$$K = \frac{k \mu}{\gamma} \quad (1)$$

where: k = hydraulic conductivity, cm/sec
 K = intrinsic or absolute permeability, cm²
 γ = permeant density or unit weight, dynes/cm³
 μ = permeant viscosity, poise

The intrinsic permeability(K) is a property only of the solids or matrix through which the permeant passes. Accordingly, for a particular soil (i.e., given grain size distribution and soil structure) and in the absence of permeant-soil reactions, K should be a constant. The influence of a variation in viscosity and density of the permeant on the hydraulic conductivity can be determined from this fact and from a relationship derived from Equation 1, viz.,

$$k_2 = k_1 \left(\frac{\gamma_2}{\gamma_1} \right) \left(\frac{\mu_1}{\mu_2} \right) \quad (2)$$

where: subscript 1 - initial conditions (grnd water)
 subscript 2 - final conditions (leachate)

An increase in density of the permeant will apparently cause a higher permeability. But, this same increase in density can also result in an increase in viscosity which will reduce the permeability. Both influences together will tend to offset one another, and it is unlikely that a density increase in the permeant (leachate) will significantly affect hydraulic conductivity. Furthermore, even if viscous retardation is discounted, density increases are highly unlikely to significantly increase permeability in actual practice as the following example will show.

Assume the ground above an aquitard or clay barrier is flooded with a fairly concentrated brine solution, namely sea water. The density of sea water (with a TDS of 36,000 ppm) is 1.036 gm/cc at 4° C vs. the density of the present interstitial water (with an average TDS of 1550 ppm) which is 1.002 gm/cc. This leads to a density ratio of 1.034 which is equivalent to only a 3.4 per cent increase in hydraulic conductivity (discounting viscous retardation). Therefore, density has little effect on hydraulic conductivity despite the almost 20 fold increase in dissolved solids concentration. It is the influence of the latter change, i.e., the increase in dissolved solids concentration, that requires careful analysis in evaluating the effectiveness of a clay barrier in containing leachate migration in this case.

C. INFLUENCE OF PERMEANT DENSITY INCREASE ON SOLUTE DIFFUSION

1. Background

Dissolved solids or solutes in a permeant can be transported through soils under both hydraulic and concentration gradients. The former is referred to as "drag coupling" and the latter as "chemico-osmotic diffusion." Both types of movement should be considered when evaluating the effectiveness of a clay barrier for preventing leachate migration.

Chemico-osmotic effects in fine grained soils have been examined in some detail by Olsen (1969) and Mitchell et al. (1973). The importance of chemico-osmotic diffusion increases in fine grained soils with low hydraulic conductivities. Studies commissioned by the State of California (1971) on salt intrusion problems in aquifer-aquitard systems have shown that as aquitards become clay rich and their permeabilities fall to levels on the order of .002 gpd/ft² or 10⁻⁷ cm/sec, the migration of solutes will be controlled by chemico-osmotic diffusion.

2. Flow of Solute under Combined Hydr. and Chem. Gradients

Equations can be derived which describe the flows of solute and solution in the pores of a sediment. The derivation of these equations and assumptions on which they are based are given by Mitchell et al. (1973). The one-dimensional, vertical, steady state flux of solute across a clay aquitard under a combined salt concentration (chemical) gradient and hydraulic gradient is given by the following relationship:

$$J_s = [(\rho_w/RT)c_s k_{ch} + c_s k_h] \partial h/\partial z + [D + c_s k_{ch}] \partial c_s/\partial z \quad (3)$$

where: J_s = salt flux across an aquitard, moles/sec/cm²
 $\partial h/\partial z$ = hydraulic gradient (dimensionless)
 $\partial c_s/\partial z$ = solute concentration gradient, moles/cm⁴
 D = diffusion constant, cm²/sec
 R = gas constant, ergs/mole/°K
 ρ_w = density of water, dynes/cc
 T = absolute temperature, °K
 c_s = average salt concentration, moles/cc
 k_h = hydraulic conductivity, cm/sec
 k_{ch} = chemico-osmotic coupling coefficient, cm⁵/mole/sec

Relative contributions to the salt or solute flux can be calculated from Equation 3. Movement of solute can occur by diffusion whether a hydraulic gradient is present or not. A superposed hydraulic gradient may retard or accelerate movement of solute depending on:

- a) Relative magnitude and direction of the hydraulic and solute concentration gradients.
- b) Values of the hydraulic conductivity and chemico-osmotic coupling coefficient.

Equation 3 only yields the steady state flux of solute under combined hydraulic and chemical gradients. Equations can also be derived that give the initial or time dependent solute fluxes and the time required for "breakthrough" or first appearance of increased solute concentration on the downstream side of the aquitard. This initial, non-steady state process is quite complicated. Examples have been worked out for aquitards of different thicknesses and composition by Mitchell et al. (1973).

One of the most important findings of these studies on salt flux across clay aquitards was the importance of aquitard thickness on breakthrough time. Because the initial movement is non-steady, the breakthrough time increases with the square of the thickness of the aquitard. Theoretical studies of salt water intrusion across aquitards (State of California, 1971) have shown that salt ions will

take up to 800 years to migrate across an aquitard 30 feet thick under chemico-osmotic diffusion alone. If the thickness is reduced to 10 feet, the breakthrough time decreases to only 80 years. The presence of an hydraulic gradient could either accelerate or retard this time depending on the relative magnitude and direction of this gradient and other factors cited previously (see Figure 3).

3. Likelihood of Solute Efflux Through Clay at Allen Park Site

Solutes will tend to migrate or diffuse downward from the landfill along a concentration gradient. On the other hand, this movement can be impeded or even arrested by the upward hydraulic gradient as a result of artesian pressure in the underlying aquifer. Static water levels in monitor wells around the landfill show that the piezometric surface is almost 10 feet above existing grade or ground surface elevation at the site (see Table 1). The net, steady state flux of solute, if any, can be determined under these conditions from the solute flow equation cited previously (Equation 3).

It is also pertinent to examine the results of a similar type of study commissioned by the State of California (1971). The latter study was designed to determine salt efflux rates and breakthrough times in an aquitard-aquifer system in the coastal ground water basin near Oxnard, California (see Figure 2). The problem posed in the California study was basically the same as the pre-sent one; namely, given a sudden increase in dissolved solids or solute concentration atop a clay barrier (or aquitard) how long before the salt migrated downward and reached an underlying aquifer and at what rates of efflux? The problem was compounded in the California example as a result of drawdown of the piezometric surface in the underlying aquifer which also caused a downward hydraulic gradient.

The two aquitards are quite similar in their important respects. Both are approximately the same thickness, have the same initial dissolved solids concentration, and are composed of clayey sediments with low hydraulic conductivities. The salient characteristics and parameters of these two aquitards are summarized and compared in Table 2. The main difference appears to be in their respective hydraulic conductivities--the Allen Park clay is an order-of-magnitude lower.

A dissolved solids concentration equal to that of sea water was assumed in the leachate overlying the Allen Park clay. Sea water is a good "worst case" choice because sodium ions have high diffusion mobilities and are not preferentially adsorbed on clay exchange sites as heavy

TABLE 1. ALLEN PARK CLAY MINE

MONITOR WELL - WATER LEVEL READINGS

Well Number	Ground Elevation, Ft.	Well Elevation ⁽¹⁾ USGS	Ground Water ⁽²⁾ Elevation 11-4-81	Δ	Ground Water ⁽³⁾ Elevation 5-29-81	Ground Water ⁽³⁾ Elevation 3-26-81
2	595.1	600.76	600.67	3.6	600.44	600.21
5	595.7	605.92	605.09	9.4	604.62	604.49
7	594.1	597.35	591.01	-3.1	593.23	594.14
10	593.4	603.03	601.81	8.4	601.93	601.56
W-101	593.9	601.47	601.21	7.3		
W-102	591.3	600.81	603.22 ⁽⁴⁾	11.9		
W-103	593.9	605.06	603.52	9.6		
W-104	594.1	603.82	603.81	9.6		
W-105	594.5	604.08	603.86	9.4		

(1) Well Elevation is recorded as top of standpipe.

$$\Delta_{W1} = 8.9$$

(2) Data Recorded by Michigan Testing Engineers, Inc.

(3) Data obtained from Michigan Department of Natural Resources.

(4) Well extended temporarily to obtain water level.

TABLE 1

TABLE 2. COMPARISON OF AQUITARD PROPERTIES AND SITE PARAMETERS

<u>AQUITARD PROPERTY OR SITE PARAMETER</u>	<u>OXNARD CALIFORNIA</u>	<u>ALLEN PARK MICHIGAN</u>
Composition	clayey silt & silty clays	silty clay
Thickness, ft	30	25 - 35
Ave. Water Content, %	24	20
Ave. Liquid Limit, %	31	28
Ave. Hydraulic Conduct, cm/sec	1×10^{-7}	2.6×10^{-8}
Hydraulic Gradient	0.33 - 1.0 (downward)	2.7 (upward)
Initial (interstitial) Pore Water Solute Conc, ppm	1800	1550
Final Solute Conc, ppm	36,000	36,000 (assumed)
Chemico-Osmotic Coupling Coefficient, $\text{cm}^5/\text{mole}/\text{sec}$	6.2×10^{-4}	6.2×10^{-4}

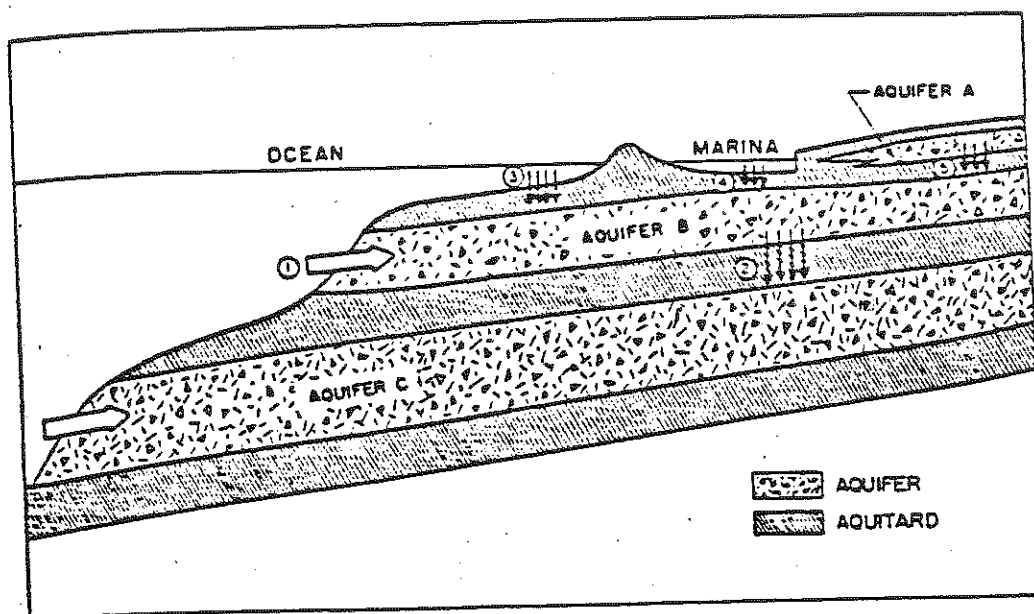


Figure 2. Generalized cross-section of multiple aquifer in a coastal basin. Salt flux across aquitard can occur as result of either salt water intrusion into aquifer (1,2) or salt water entering directly above aquitard in shallow coastal waters or marinas (3,4), or from salt contamination in near surface, perched aquifer (5).

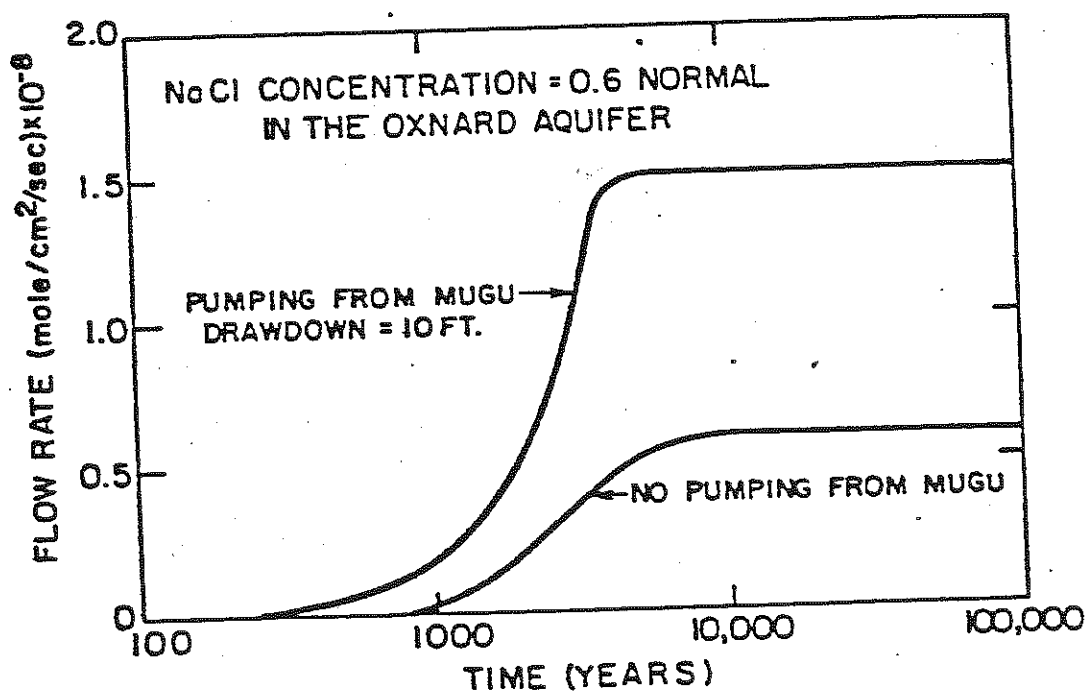


Figure 3. Solute efflux across aquitard into underlying aquifer as a result of salt water intrusion in overlying aquifer. Aquitard is 30 feet thick and has a hydraulic conductivity of 10^{-7} cm/sec. Pumping from lower (Mugu) aquifer superposes a 0.33 downward gradient on system.

metal ions would tend to be. The same chemico-osmotic coupling coefficient used in the California aquitard was also assumed applicable for the Allen Park clay. The value used is reasonable for the type of clay sediments present.

Results of the California study are presented in Figure 3 which shows the salt influx into the underlying aquifer as a function of time. Curves are presented for a no drawdown and 10-foot drawdown case (assuming the hydraulic gradient acts in the same direction as the salt concentration gradient). The horizontal portion of the two curves represents the steady state salt flux.

The main things to notice from this figure are the large breakthrough time (800 years) for the "no drawdown" case (i.e., in the absence of any hydraulic gradients) and the fact that in this aquitard the salt flux caused by drag coupling under a hydraulic gradient is larger. The steady state salt flux from the drag coupling under a combined 10-foot drawdown and salt concentration gradient is almost three times that from diffusion alone (no drawdown). Hence, in the event the hydraulic gradient was reversed, there would be no breakthrough and no downward salt flux provided the upward gradient exceeded about 0.2. In other words, under these conditions the two salt fluxes would be mutually opposed and exactly counterbalanced.

The relative contributions to steady state efflux in this example can be calculated with the aid of Equation 3. The following parameter values (taken from the study) were used in the calculation:

$$\partial h / \partial z \approx \Delta h / \Delta L = 10/30 = 0.33$$

$$\partial c / \partial z \approx (c_{s_2} - c_{s_1}) / \Delta L = \frac{0.57 \times 10}{914} = 0.62 \times 10 \text{ moles/cm}^4$$

$$c_s = (c_{s_2} + c_{s_1}) / 2 = \frac{(0.60 - 0.03) \times 10}{2} = 0.32 \times 10 \text{ moles/cm}^3$$

$$D = 10^{-5} \text{ cm}^2/\text{sec}$$

$$R = 8.32 \times 10^7 \text{ ergs/mole/}^\circ\text{K}$$

$$T = 300 \text{ }^\circ\text{K}$$

$$\gamma_w = 10^3 \text{ dynes/cc}$$

$$k_h = 10^{-7} \text{ cm/sec}$$

$$k_{ch} = 6.2 \times 10^{-4} \text{ cm}^5/\text{mole/sec}$$

Using these values the calculated contributions to steady state solute flux are respectively:

Drag Coupling: $J_{s_1} = [(\gamma_w/RT)c_s k_{ch} + c_s k_h] \partial h / \partial z$

$$= \left[\frac{10^3 (2 \times 10^{-7})}{8.32 \times 10^7 (.3 \times 10^{-3})} + 0.32 \times 10^{-3} (10^{-7}) \right] 0.33$$

$$= 1.056 \times 10^{-11} \text{ moles/sec/cm}^2$$

$$= \underline{0.98 \times 10^{-8} \text{ moles/sec/ft}^2}$$

Chemico-Osmotic Diffusion:

$$J_{s_2} = [D + c_s k_{ch}] \partial c_s / \partial z$$

$$= [10^{-5} + 2 \times 10^{-7}] 0.62 \times 10^{-6}$$

$$= 0.63 \times 10^{-11} \text{ moles/sec/cm}^2$$

$$= \underline{0.58 \times 10^{-8} \text{ moles/sec/ft}^2}$$

The total salt flux is the sum of the contributions from drag coupling and chemico-osmotic diffusion or

$$J_s = J_{s_1} + J_{s_2}$$

$$= (0.98 + 0.58) \times 10^{-8}$$

$$= \underline{1.56 \times 10^{-8} \text{ moles/sec/ft}^2}$$

These calculations are in agreement with the results shown in Figure 3 for steady state salt inflow under combined gradients. They also illustrate that the drag coupling contribution under a 10-foot drawdown (0.33 hydraulic gradient) exceeds the chemico-osmotic diffusion contribution.

In the case of the clay aquitard beneath the landfill at Allen Park, the average hydraulic conductivity is almost an order-of-magnitude lower (2.6×10^{-8} vs. 10^{-7} cm/sec). This will tend to decrease the drag coupling. On the other hand, this tendency will be more than offset by higher hydraulic gradients at this site. If the level of the leachate is kept at or close to the bottom of the landfill, then the gradient will approach 80/30 or 2.7. The drag coupling component of solute flux in this case will be

$$J_{s_1} = \left[\frac{10^3 (2 \times 10^{-7})}{8.32 \times 10^7 (.3 \times 10^{-3})} + 0.32 \times 10^{-3} (2.6 \times 10^{-8}) \right] \times 2.7$$

$$= [0.008 \times 10^{-12} + 0.832 \times 10^{-11}] \times 2.7$$

$$= 2.25 \times 10^{-11} \text{ moles/sec/cm}^2$$

$$= \underline{2.09 \times 10^{-8} \text{ moles/sec/ft}^2}$$

This flux is greater than 3X the chemico-osmotic flux; and since it acts in the opposite direction, there will be no net downward flux of solute at the Allen Park site. The critical hydraulic gradient to maintain a zero net salt efflux is 0.8. This means that the groundwater table could rise to within 12 feet of present ground elevation (~595 ft) in the landfill and there would still be a sufficient upward hydraulic gradient (drag coupling effect) to completely counter solute efflux under chemico-osmotic diffusion (see summary below).

<u>Position of Ground Water Table in the Landfill</u>	<u>Upward Hydraulic Gradient</u>	<u>Net, Steady State Solute Efflux Rate (moles/sec/ft²)</u>
At bottom	2.7	-1.51 x 10 ⁻⁸ (net influx)
12 feet from top	0.8	zero
At top	0.33	+0.32 x 10 ⁻⁸

These calculations are based on the existence of a static or piezometric head in the underlying aquifer approximately 9-10 feet above ground elevation (see Table 1).

Assumption of worst case conditions, namely, a rise in the groundwater table in the landfill to ground surface elevation, leads to a small, steady state efflux rate from chemico-osmotic diffusion. This occurs because the resulting hydraulic gradient (0.33) is no longer large enough to completely oppose the chemico-osmotic salt flux. The breakthrough times, however, would be so immense (1000's of years) that the steady state flux under these conditions is largely irrelevant.

It is important to note that the preceding calculations are also based on the following "worst case" assumptions:

1. A highly saline leachate with a concentration and composition equal to that of sea water.
2. No interaction between the solute and clay.

In actual practice, there would be some uptake and adsorption of solutes on the clay. This adsorption would attenuate or limit further solute concentrations in the leachate as it passed through the clay.

III. EFFECT OF LEACHATE CONSTITUENTS ON THE PERMEABILITY OF CLAY

A. GENERAL BACKGROUND

The possibility that leachate--either in the solvent or solute phase--might affect clay permeability and hence its containment integrity has been raised by a number of investigators (Anderson and Brown, 1981; Haxo, 1981; and Folkes, 1982). One of these studies has shown that concentrated organic liquids can increase clay permeability by several orders-of-magnitude (Anderson and Brown, 1981).

All of these studies were conducted in the laboratory with simulated leachates from particular types of wastes and under particular testing conditions. The danger of blindly applying these test results to a field situation have been noted recently by Gray and Stoll (1983). It is essential to ask the following before the results of these lab tests can be applied to a given field situation:

1. What was the nature of the leachate in the lab tests? What are the concentrations of various constituents in the leachate in the field as opposed to the lab tests? How relevant are the lab test results in the light of potentially large differences in leachate composition (lab vs. field)?
2. How did the leachate contact or interact with the clay in the lab tests? Was it forced through? If so, at what gradient? Is there any prospect that the leachate will be able to penetrate/permeate through the clay containment in the field in like manner? In other words are the necessary gradients and other conditions present to permit this to happen?
3. What was the failure or clay degradation process by which the apparent permeability increase occurred in the lab tests? Was it by a) dissolution, b) syneresis, c) piping? Could these mechanisms reasonably occur in the field given the type, water content, and density of the in-situ clay plus the nature and concentration of organic and inorganic compounds in the leachate?

B. WASTE AND LEACHATE COMPOSITION AT THE ALLEN PARK CLAY MINE

The types, composition, and relative amounts of wastes placed in the Type II Solid Waste Landfill at Allen Park are shown in Tables 3 and 4. The results of typical E.P.T leachate tests on these wastes are shown in Table 5. The likely nature and composition of the landfill leachate can be estimated from this information. This estimate is adequate for purposes of evaluating the probable effect of the leachate on clay permeability.

TABLE 3. ALLEN PARK CLAY MINE - SOLID WASTE
LANDFILL CONSTITUENTS

Fly Ash	-	50%
Blast Furnace Filter Cake	-	15%
Construction Debris - Sweepings - Clean-Up	-	14%
BOF Dust	-	6%
Foundry Sand	-	6%
Electric Furnace Dust	-	4.8%
Coal and Coke	-	3%
Coke Oven Decanter Tar Sludge	-	0.6%
Glass	-	0.5%
Wood Ash	-	0.5%
BOF Kish	-	0.3%
Wastewater Treatment Sludge	-	0.2%
Grinding Mud	-	0.1%

TABLE 4. ALLEN PARK CLAY MINE WASTES. TYPICAL
AS RECEIVED ANALYSES (mg/kgm).

	Decanter Tank Tar Sludge	Electric Arc Furn. Dust	Blast Furn. Flue Dust	BGF Flue Dust	Blast Furn. Filter Cake	Foundry Sand	BGF Kish	Fly Ash	Lime Dust	Coke Breeze
EP Toxic	No	Yes (Zn, Pb, Cd)	No	No	No	No	No	Exempt	No	No
Iron	----	350,000	122,000	560,000	150,000	1,200	490,000	34,500	----	5,000
Carbon	----	4,700	520,000	7,400	404,000	6,600	240,000	194,000	----	550,000
Arsenic	----	50	19	42	2	20	70	----	----	15
Barium	----	<1	<1	<1	20	<1	<1	----	----	<1
Cadmium	----	95	<1	50	0	<1	<1	----	----	<1
Chromium	----	500	<1	130	70	<1	60	----	----	1
Lead	----	<4,500	<1	3,000	350	44	<1	----	----	69
Mercury	----	<1	<1	<1	<1	<1	<1	----	----	<1
Selenium	----	120	90	<1	<1	35	70	----	----	3
Silver	----	6	<1	<1	9	<1	<1	----	----	19
Manganese	----	39,000	7,500	10,000	4,500	79	2,000	----	----	70
Zinc	----	150,000	120	22,000	400	40	194	----	----	110
Phosphorus	----	450	200	190	300	400	170	----	----	90
Sulfur	----	3,600	4,000	1,600	4,000	200	850	3,100	----	7,300
Calcium	----	61,000	18,000	2,000	20,000	60	580	13,100	714,700	300
Magnesium	----	11,000	7,500	9,600	13,000	100	3,200	5,400	----	300
Aluminum	----	2,400	2,200	<2	3,700	<2	1,600	147,200	----	<2
Silicon	----	15,000	20,000	8,000	83,000	450,000	25,000	201,700	----	20,000
Potassium	----	5,900	900	5,000	2,202	170	640	9,700	----	220
Sodium	----	5,200	440	2,300	1,500	390	630	3,700	----	650
Fluorine	----	26	10	23	4	<1	48	----	----	<1
Cyanide	14	<1	<1	<1	3	<1	<1	----	----	2
Phenol	1,800	<1	<1	<1	3	<1	2	----	----	3
Naphthalene	2,700	----	----	----	----	----	----	----	----	----

TABLE 5. ALLEN PARK CLAY MINE SOLID WASTES
TYPICAL E.P.T. LEACHATE TEST RESULTS (MG/L)

Parameter	Blast Furnace Flue Dust	BOF Flue Dust	Blast Furnace Filter Cake	Foundry Sand	BOF Kish	Coke Breeze	Wastewater Treatment Sludge
Arsenic	0.04	0.02	< 0.1	0.03	0.1	< 0.1	.008
Barium	< 0.8	< 0.04	< 0.8	< 0.08	< 0.8	< 0.8	.45
Cadmium	0.01	0.03	< 0.08	< 0.005	< 0.005	< 0.005	.005
Chromium	< 0.1	< 0.05	< 0.05	< 0.1	< 0.1	< 0.1	.101
Lead	< 0.2	1.7	1.7	< 0.2	< 0.2	< 0.2	.025
Mercury	0.0007	< 0.01	< 0.2	< 0.2	< 0.2	< 0.2	.0005
Selenium	1.0	< 0.01	< 0.2	0.10	0.4	< 0.5	.008
Silver	< 0.1	< 0.01	< 0.01	< 0.1	< 0.1	< 0.1	.006

Compiled By: J. H. H. H.
March 1, 1955

The data in Tables 3 and 4 indicate that 50 per cent of the solid waste consists of relatively inert fly ash and that some 89 per cent of the wastes consist of materials that do not contain significant amounts of heavy metals (Zn, Pb, Cd) or organics known or suspected to be toxic such phenol and naphthalene (see Table 4). The coke oven decanter tar sludge is a possible source of organics (phenol and naphthalene), but this waste comprises only 0.6 per cent of the total stream in the Type II Solid Waste landfill.

C. PROBABILITY OF ORGANICS IN LEACHATE AFFECTING CLAY PERMEABILITY AT ALLEN PARK SITE

Anderson and Brown (1981) found that several organic liquids, viz., aniline, acetone, ethylene glycol, heptane, and xylene, cause large increases in permeability of four compacted clay soils. Pure organic liquids were used in their study. One of the authors (Anderson, 1982) later emphasized that their results cannot be used to support claims that clay liners permeated by dilute organic liquids may be susceptible to large permeability increases.

Haxo (1981) reported results of up to 52 months of liner exposure to selected industrial wastes. He included several organic wastes, namely, aromatic oil, Oil pond 104, and a pesticide. The results of large permeameter tests on a compacted fine-grained soil and admixed materials are summarized in Table 6. Although a small amount of seepage passed through the compacted, fine-grained soil liner, no permeability increases were reported with any of the organic wastes.

On the basis of these studies and with the caveats noted at the beginning of this section in mind, it is possible to evaluate the likely effect of the landfill leachate on clay permeability at the Allen Park site.

1. Type II Solid Waste Landfill

As noted previously the existing landfill contains small quantities of coke oven decanter tar sludge which is a possible source of organics (phenol and naphthalene), but this waste comprises only 0.6 per cent of the total. Phenol and naphthalene are present in the tar component of this waste in concentrations estimated by Desha (1946) of 0.1 and 2.2 per cent by weight respectively. Accordingly, the amount of phenol and naphthalene present in the total waste stream are .006 and .013 per cent by weight respectively. These amounts constitute a very low fraction and they suggest that leachate from the total waste stream will tend to have very low concentrations of phenol and naphthalene. Therefore, the organics in the leachate from the Type II Solid Waste landfill are quite unlikely to affect clay permeability.

TABLE 6. EFFECTS OF INDUSTRIAL WASTES ON SOIL AND ADMIX LINERS
(from Haxo, 1981)

Liner material	Acidic waste (HNO ₃ , HF, HOAC)	Alkaline waste (spent caustic)	Lead (low lead gas washing)	Oily waste		Pesticide (weed killer)
				Aromatic oil	Oil pond 104	
Compacted fine-grained soil 305 mm thick	Not tested	Measurable rate of seepage $v_s = 10^{-10} - 10^{-9}$ m/s, waste penetrated 3-5 cm after 30 months (a)		$k = 1.8 \times 10^{-10}$ $k = 2.4 \times 10^{-10}$ $k = 2.6 \times 10^{-10}$ (tests on soil after 30 months)	†	†
Soil cement 100 mm thick	Not tested	No measurable seepage after 30 months				
Modified bentonite and sand (2 types) 127 mm thick	Not tested	Measurable seepage after 30 months, channelling of waste into bentonite (b)			Failed (waste seepage through liner)	‡
Hydraulic asphalt concrete 64 mm thick	Failed	Satisfactory	Waste stains below liner asphalt mushy	Not tested	Not tested	Satisfactory
Spray-on asphalt and fabric 8 mm thick	Not tested	Satisfactory	Waste stains below liner	Not tested	Not tested	Satisfactory

*From data presented by Haxo (1981).

†Same as (a).

‡Same as (b).

2. Type I Hazardous Waste Landfill

In the future the decanter tar sludge will be placed in a separate landfill that will be upgraded to accept hazardous wastes. This action will increase the relative proportion of organics (phenol and naphthalene) in the waste stream. Leachate tests run on pure samples of decanter tar sludge using a distilled water extraction procedure (Calspan, 1977) have produced phenol concentrations of approximately 500 ppm. Even this concentration is far removed from the very high concentrations of organic solvents used by Anderson and Brown (1981) in their permeability tests on different clays. Accordingly, organics in the leachate from the Type I Hazardous Waste landfill are also unlikely to affect clay permeability.

In summary: It does not appear likely nor reasonable that organics present in the wastes at the Allen Park Clay Mine/Landfill will cause a permeability increase given their low concentration and the absence of any substantiation in the published technical literature for such an increase under these conditions.

IV. CONCLUSIONS

- (1). There appears to be very little likelihood of leachate migrating downward from the Allen Park Clay Mine/Landfill and contaminating the aquifer beneath the clay.
- (2). A density difference between the leachate and groundwater will have little or no influence on hydraulic permeability or downward migration nor will it lead to diffusion efflux of solutes. A thick, uniform bed of silty clay beneath the site coupled with an upward hydraulic gradient precludes the latter. Calculations and analyses are provided herein to support this finding.
- (3). Comparison with results of salt water intrusion studies across clay aquitards having similar properties as the clay beneath the Allen Park Clay Mine site show that the solute (salt) will take at least 800 years to migrate across a clay barrier 30 feet thick under chemico-osmotic gradients alone. A counter (or upward) hydraulic gradient will increase this breakthrough time even more.
- (4). The waste and its leachate are unlikely to increase the permeability of the underlying clay. This claim is reasonable in view of the low concentrations of organics in the total waste stream and in the light of the findings and caveats of permeability/exposure tests with organic permeants reported in the technical literature. This conclusion applies to both the existing Type II Solid Waste landfill and a proposed Type I Hazardous Waste landfill that will accept the coke oven decanter tar sludge.
- (5). The composition of the waste and underlying clay do not suggest properties or combination of properties that could lead to a containment failure caused by such processes as piping, acid/base dissolution, or syneresis.
- (6). Under these circumstances any observed increase in contaminant levels of monitor wells in the aquifer underlying the site could just as well come from other sources laterally upgradient from the site rather than from the clay mine/landfill above the site.
- (7). These findings and conclusions support the basis of applicant's petition for discontinuing further monitoring of the wells penetrating the aquifer beneath the site.

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JULY 1983 REPORT
CONTAINMENT INTEGRITY OF ALLEN PARK
CLAY MINE/LANDFILL

1704 Morton Street
Ann Arbor, Michigan
48104

25 September 1983

Mr. Mark Young
Wayne Disposal Company
P.O. Box 5187
Dearborn, MI 48128

RE: Allen Park Clay Mine/Landfill

Dear Mark:

I recently wrote a computer program (*CLAYWALL*) that can be used to calculate solute transport across a clay barrier under combined diffusion and advection (hydraulic flow). The program computes the exit/source concentration ratio (C/C_0) as a function of elapsed time (t) on the downstream side of a clay wall or barrier of thickness (X).

The program was written with a clay slurry cut-off wall in mind, but is general enough that it can be used with any clay layer or barrier. The input parameters to the program are:

D_e = effective diffusion coefficient, ft^2/yr
 K = hydraulic permeability, ft/yr
 X = thickness of wall or barrier, ft
 P = porosity
 I = hydraulic gradient... (+) if same direction,
(-) if opposite direction to solute concentration gradient
 t = elapsed time, yrs

The program is based on the solution to the equation that describes one-dimensional solute transport in a saturated porous medium under both hydraulic and solute concentration gradients. This equation has the following form:

$$C/C_0 = 0.5[\text{erfc}((X-vt)/\text{sqr}(4DK)) + \exp(vX/D) \text{erfc}((X+vt)/\text{sqr}(4DK))]$$

where: v = ave seepage velocity = (KI/P)

The solution assumes the following conditions:

1. Saturated, one-dimensional flow.
2. No reaction between solutes and porous medium. Chloride typically behaves this way.

3. Diffusion controlled, i.e., the pore water velocity is so low that mechanical mixing is negligible and the dispersion is equal to the effective diffusion coefficient. (this condition is satisfied when $K < 1.0E-07$).

I ran the program using data for the silty clay layer underlying the Allen Park ClayMine/Landfill. The following values for the input data were used:

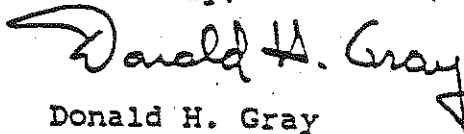
$D = 0.102 \text{ ft}^2/\text{yr}$ ($6.3E-06 \text{ cm}^2/\text{sec}$)
(published value for clay tills)
 $K = 0.025 \text{ ft/yr}$ ($2.5E-08 \text{ cm/sec}$)
 $X = 30 \text{ ft}$
 $P = 30 \%$
 $I = -0.1, -0.3, \text{ and } -1.0$

The results of the analysis are shown in the attached graph. At a counter hydraulic gradient of -0.3 the exit/source solute concentration ratio does not exceed 0.0001 until 700 years have elapsed. You may recall that a counter hydraulic gradient of -0.3 occurs when the leachate is allowed to rise in the landfill to the ground surface...a worst case scenario. For larger (negative) counter hydraulic gradients the ratios become even smaller. In fact for $I < -0.5$ (i.e., counter hydraulic gradients larger than 0.5) the ratio C/C_0 is less than $1.0E-05$ at all elapsed times.

These results confirm the findings of my earlier report which were based largely on analogy to solute transport studies in clay aquitards. The present findings are based on analysis of actual soil and site parameters. Keep in mind, also, that the analysis is still quite conservative because it neglects possible adsorption (reaction) of solutes with the clay.

A copy of the computer program and typical output are enclosed. It is written in BASIC and is designed to be run on a personal computer. If you have any questions about the analysis, please feel free to contact me.

Sincerely,



Donald H. Gray
Professor of Civil Engineering

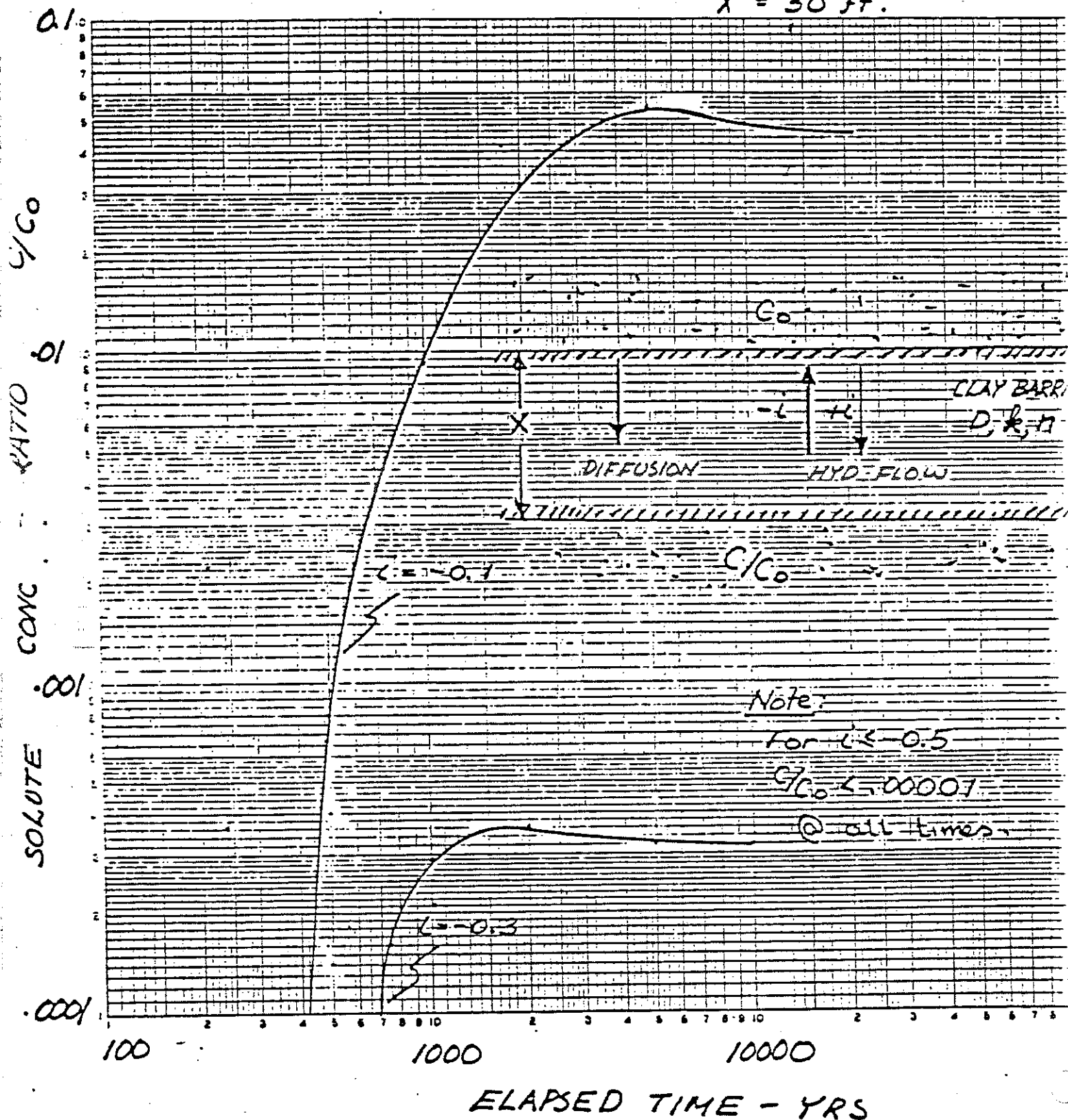
Encl

$$D = 0.102 \text{ ft}^2/\text{yr} \quad (3 \times 10^{-6} \text{ cm}^2/\text{s})$$

$$k = 0.025 \text{ ft/yr } (2.5 \times 10^{-8} \text{ cm/s})$$

$$n = 30\%$$

$$X = 30 \text{ ft.}$$



run
Porosity: 0.3
Permeability(ft/yr): .025
Diffusion Coef(ft /yr): 0.102
Wall Thickness: 30
Hydraulic Gradient: -0.3
Time(yrs): 500

1st Argument(Y1)is: 2.9756
1st Error Function is: 0.9999
2nd Argument(Y2)is: 1.22525
2nd Error Function is: 0.9173
Exit/Source Concentration Ratio (C/Co)is:

8E-05

Continue Calculations (y/n) ? y

Time(yrs): 750

1st Argument(Y1)is: 2.78685
1st Error Function is: 0.99979
2nd Argument(Y2)is: 0.64312
2nd Error Function is: 0.63658
Exit/Source Concentration Ratio (C/Co)is:

2.2E-04

Continue Calculations (y/n) ? y

Time(yrs): 1000

1st Argument(Y1)is: 2.72291
1st Error Function is: 0.99973
2nd Argument(Y2)is: 0.24754
2nd Error Function is: 0.27399
Exit/Source Concentration Ratio (C/Co)is:

3.7E-04

Continue Calculations (y/n) ? y

Time(yrs): 2000

1st Argument(Y1)is: 2.80056
1st Error Function is: 0.9998
2nd Argument(Y2)is: -0.70014
2nd Error Function is: 0
Exit/Source Concentration Ratio (C/Co)is:

4.2E-04

Continue Calculations (y/n) ? y

Time(yrs): 5000

1st Argument(Y1)is: 3.43176
1st Error Function is: 0.99998
2nd Argument(Y2)is: -2.10334
2nd Error Function is: 0
Exit/Source Concentration Ratio (C/Co)is:

3.3E-04

Continue Calculations (y/n) ? n

Department of Natural Resources
Michigan Department of Natural Resources
Land Division

1704 Morton Street
Ann Arbor, MI 48104

16 February 1984

MINING PROPS.

22 FEB 84 8:20

Mr. David S. Miller
Mining Properties Department
Rouge Steel Company
3001 Miller Road
Dearborn, MI 48121

RE: Allen Park Clay Mine/Landfill

Dear Dave:

I have reviewed the memorandum dated January 23, 1984, from Terry McNeil, Technical Services Section, to Larry Aubuchon, Compliance Section, Detroit District, MDNR. The memorandum essentially raises the following objections to the findings and conclusions in my report, viz.,

Objection 1. There is no substantiation nor literature citations to show that organics present in the waste will not increase permeability.

Objection 2. The presence and possible effects of naphthalene in the waste are disregarded.

Objection 3. Uncertainties remain about the actual composition and likely nature of the leachate.

Objection 4. The report does not address the question of compatibility between the following:

- a) Leachate and leachate collection system components
- b) Generated gases and clay cap.

In the opinion of the MDNR reviewer Objections 1,2,and 3 taken together mean that Specific Condition 5.A.4 (a) of Act 64 license is not satisfied. The reviewer goes on to say, however, that they (MDNR) would accept compatibility testing between actual leachate being generated and the on-site clay being used for containment. I will respond herein to these stated objections and opinion. Objection 4 which pertains to Specific Condition 5.A.4 (b) and (c) is outside the scope and original charge of my investigation.

Objection 1 is a version of the "guilty until proved innocent" syndrome. I understand and even sympathize with this approach in matters which deal with the release of potentially hazardous substances into the environment. There is, however, considerable substantiation in the published technical literature for the contention that organics present in low concentrations in aqueous leachate will not increase the permeability of dense clays.

Leachate permeability tests on sand-clay columns packed to bulk densities within the range of densities of natural clays (Cartwright et al., 1977) have shown that permeability actually decreased with passage of leachate (containing organics). These tests were continued for periods up to nine months. Decreases were even more pronounced for raw, unsterilized leachate. In addition to permeability reduction from the passage of leachate, Griffin and Shimp (1976) have shown that heavy metal ions (Pb, Zn, Cd, Hg) are strongly attenuated by clay. Organics that were present in the leachate were only moderately attenuated by the clay; they did not increase hydraulic conductivity. We have also conducted long term leachate permeability tests ourselves on a silty clay almost identical in composition to the clay underlying the Allen Park Clay Mine/Landfill site (Gray, 1982) and found the same results, i.e., no increase in permeability was observed. A chemical analysis of the leachates used in all these permeability tests is attached. Note the presence of naphthalene in one of the leachates--a constituent whose presence and influence the MDNR reviewer claimed we had not considered. [Note: Cited references are listed in an attachment to this letter report.]

It is important to emphasize again the fact that leachate permeability tests conducted by Anderson (1982) are totally unrepresentative of conditions at the Allen Park site. These tests are often cited as an example of the deleterious influence of organic solvents on clay liner permeability. Anderson's tests are unrepresentative and irrelevant for the following reasons:

1. He used pure organic solvents. The leachate at the Allen Park Clay Mine/Landfill will be an aqueous extract containing very low concentrations of organics.
2. He forced the solvents through clays at extremely high, positive gradients. Anderson used positive gradients ranging from 60 to 300. At the Allen Park site there will be negative (reverse) gradients ranging on the order of -0.3 (worst case) to -2.7.

Other objections can also be cited in regard to Anderson's test procedures and results. He used a rigid wall permeameter which permits channeling between sample and container. The recommended procedure to avoid this potential problem is to use a flexible, pressurized jacket. Large reported increases in permeability should be viewed with some skepticism when rigid wall permeameters have been employed.

Green et al. (1981) have investigated in great detail the characteristics of organic solvents that affect their rate of movement (permeability) in compacted clay. They measured the equilibrium permeability of three clays (a clay shale, a fire clay, and kaolinite) to the following solvents: benzene, xylene, carbon tetrachloride, trichloroethylene, acetone, methanol, glycerol, and water. Their study showed that it is the hydrophilic or

hydrophobic nature of the solvent (as measured by the octanol/water partitioning coefficient or roughly by the dielectric constant) and not the viscosity/density ratio that is important in predicting a solvent's rate of flow through clays. According to their findings water, which has a high dielectric constant, always exhibited the highest permeability. In addition, they found that the packed clay density is crucial in determining how permeable a clay will be to a given solvent. At high bulk densities (on the order of 115 pcf or 1.85 g/cc) the solvent characteristics became less important in differentiating permeability response.

Green *et al.* (1981) also observed that solvents of low dielectric constant (e.g. xylene and carbon tetrachloride) tended to cause shrinkage and cracking of some of the clays. This phenomenon, known as syneresis, can and eventually did cause an apparent permeability increase in some of the clays that were tested. The same phenomenon was reported by Anderson (1982) in some of his experiments. It must be emphasized again, however, that the effect has only been observed and reported when several pore volumes of pure, low-dielectric organic solvents are forced at very high gradients through clay columns. These conditions simply do not occur at the Allen Park Clay Mine/Land-fill site.

On the contrary, the conditions at the Allen Park site are ideal for effective containment, viz.,

1. The site is underlain by a thick ($X \geq 25$ ft) section of dense, competent silty clay ($\gamma_p = 115$ pcf) with a very low hydraulic conductivity ($k = 2 \times 10^{-6}$ cm/sec)
2. A negative hydraulic gradient exists at the site as result of artesian conditions in the underlying aquifer. Even under worst case assumptions (viz., leachate levels rising to the top of the landfill) a negative gradient of -0.3 will still be present.
3. The leachate consists of very low concentrations of organic and inorganic solutes in an aqueous solution as opposed to a pure solvent.

Under these conditions advective transport or hydraulic seepage ceases to dominate pollutant movement across a clay barrier (see Gilbert and Cherry, 1983; Tallard, 1984). Instead, diffusion under chemical concentration gradients becomes more important, and it is this transport mechanism that must be evaluated carefully. I have dealt with this problem both in my original report and in my subsequent letter report to Mr. Mark Young, Wayne Disposal, Inc., dated 25 September 1983. I showed that even under worst case assumptions of no partitioning or attenuation of pollutants and minimum, negative hydraulic gradients breakthrough times would be on the order of thousands of years. Interestingly, if the calculations are repeated allowing the

hydraulic conductivity or permeability to double or even triple, the breakthrough time increase even more because now the counter advective flow is more effective in opposing the downward diffusion of solutes along their concentration gradient.

I come now to the MDNR comments about requiring compatibility testing (whatever that means) between actual leachate and the clay liner material. Unfortunately, the procedure, rationale, etc. for such tests are not specified. What is being required ...that the leachate be forced under high hydraulic gradients through a thin sample of the silty clay? The results or significance of such a test would be ambiguous at best and meaningless at worst in this case. In my opinion, such tests would be an exercise in futility and irrelevance given the condition and circumstances at the Allen Park Clay Mine/Landfill site.

Breakthrough times in diffusion controlled transport are extremely sensitive to thickness of the barrier. In order to replicate conditions in the field at Allen Park, compatibility or flow tests should be run on a sample column 25 feet high under a negative gradient no less than -0.3. After a wait time of thousands of years such a test would merely confirm what is already demonstrable.

It is my professional opinion that in this instance the requirement for compatibility testing and concern over permeability is a diversion from the real issue which is the likelihood of diffusion transport of solute across the clay. I have shown that this will not be a problem at the Allen Park Clay Mine/Landfill site because of the thickness, competency, and density of the underlying clay together with the existence of a negative gradient.

I find it baffling that MDNR can approve a thin, clay slurry wall for a toxic waste site (see Consent Judgment, U.S. District Court, U.S. Envl. Protection Agency and The State of Michigan, Plaintiffs, vs. Velsicol Chemical Corp., Defendant) based on meagre and inadequate evaluation whilst insisting on irrelevant tests for a thick, natural clay containment system at Allen Park that is ideal in nearly every respect.

Sincerely,

Donald H. Gray

Donald H. Gray
Professor of Civil Engineering

Attachments

ATTACHMENT NO. 1 - CITED REFERENCES

- Anderson, D. (1982). Does landfill leachate make clay liners more permeable? Civil Engineering, ASCE, Vol. 52, pp. 66-69
- Cartwright, K., Griffin, R.A., and Gilkeson, R.H. Migration of landfill leachate through glacial tills, Groundwater, Vol. 15, No. 4, pp. 294-305
- Gilham, R.W. and Cherry, J.A. (1983). Predictability of solute transport in diffusion-controlled hydrogeologic regimes, Proceedings, Symposium on Low-Level Waste Disposal, U.S. NRC, NUREG/CP-0028, Conf-820911, Vol. 3, pp. 379-410
- Gray, D.H. (1982). Influence of leachate on clay liner permeability, Wayne Disposal landfill site, Report prepared for Wayne Disposal, Inc., September 1982
- Green, W.J., Lee, F.G., and Jones, R.A. (1981). Clay-soils permeability and hazardous waste storage, Journal of WPCF, Vol. 53, No. 8, pp. 1347-1354
- Griffin, R.A. and Shimp, N.F. (1976). Attenuation of pollutants in municipal landfill leachate by clay minerals, Cincinnati Ohio: Final Report for U.S. Env'l Protection Agency, Contract 68-03-0211
- Tallard, G. (1984). Slurry trenches for containing hazardous wastes, Civil Engineering, ASCE, Vol. 54, No. 2, pp. 41-45

ATTACHMENT NO 2

Table 2. Chemical Analysis of Landfill Leachates

<u>Analysis</u>	<u>DuPage County Landfill-mg/l</u>	<u>Wayne Disposal Landfill-mg/l</u>
Na	748	3400
K	501	-
Ca	47	46
Mg	233	370
Cu	<0.1	0.55
Zn	18.8	5.0
Pb	4.46	0.91
Cd	1.95	0.10
Ni	0.3	0.40
Hg	0.0008	0.010
Cr	<0.1	0.31
Fe	4.2	7.77
Mn	<0.1	-
Al	<0.1	-
NH ₄	862	1540
As	0.11	0.0044
B	29.9	<0.005
Si	14.9	-
Cl	3484	5800
SO ₄	<0.1	200
NO ₃	-	<0.1
HCO ₃	-	6920
COD	1340	2160
TOC	-	2500
TSS	-	512
pH	6.9	7.6
Spec. Cond. (mmhos/cm)	10.2	28.0
Equiv. TDS	6528	17,920
Organics:		
organic acids (phenol)	0.3	3.6
toluene	-	0.45
napthalene	-	0.44
chlorobenzene	-	0.008

L. M. MILLER & ASSOCIATES

CONSULTING ENGINEERS & GEOLOGISTS

2500 PACKARD RD., SUITE 2106
ANN ARBOR, MICHIGAN 48104

June 17, 1982

Rouge Steel Company
Division of Mining Properties
3001 Miller Road
P.O. Box 1699
Dearbor, Mi 48121

Attention: Mr. David Miller

Re: Allen Park Clay Mine Seismic Survey

Dear Mr. Miller:

As per your request a seismic study was performed at the Allen Park Clay Mine area in Allen Park, Michigan. The purpose of this study was an attempt to determine the depth to bedrock in the area immediately below the excavated pit at the disposal area.

Keeping consistent with previous seismic work accomplished in the area these stations were numbered 4, 5 and 6. Stations 4 and 5 were completed on the excavated pit floor, 4 being on the eastern half and 5 on the western side of the pit floor, with station 6 directly to the north of the pit up on approximately the existing surface elevation, some 30 to 40 feet above the pit floor. Plots of the data collected are included and indicate both the velocities of the layers and the depths to the layer interfaces.

Station 4 resulted in the best data collected at the site, and shows a three-layer case. A low velocity (1428 ft/sec) layer is underlain by a very consistent layer with a velocity of 5233 ft/sec, extending to a depth of 57 feet below the pit floor where it is underlain by a much higher velocity (12,808 ft/sec) layer. These values are very typical of a dense clay layer underlain by a hard limestone type material. The rather good fit of the data to a line would indicate very consistent materials, however, the irregularities near the 57 foot contact indicate that this interface is not as sharp a transition and hence it represents more of a minimum depth to this interface.

At Station 5 area surface topography was rough and inconsistent which resulted in limited data being collected. In one area a very steep depression was encountered on the surface which the shock wave source worked in. This abrupt lowering of the elevation causes a decrease in the time it takes to the shock wave to travel through the subsurface. Therefore, the best fit line was drawn through only those points where the shock wave source was at the approximate same elevation. Had the elevation been consistent, the travel times for those distances, which were lower, would have been increased in the direction towards this line.

Station 5 showed approximately the same subsurface conditions as did 4, with a depth to the bedrock being indicated at 70 feet below the pit floor. Station 6 was run at a much higher elevation than that of the pit floor, and very soft wet surface conditions were found. These types of surface conditions do not allow for seismic shock waves to propagate as the material tends to absorb much of the energy and transmit this energy directly across the surface rather than down into the earth. This data indicates again a rather consistent layer with a velocity typical of a dense clay. As a rule of thumb, seismic tests measure in depth roughly one-third the distance from the energy source to the geophone. Using this rule the limits of our data would be to a depth of approximately 45 feet for the clay layer and would obviously extend until the next layer is encountered.

We hope that this information is useful to you. If any further information on subsurface conditions is needed, it should be noted that there is enough room in the bottom of the excavated pit for an electrical resistivity test to be run. The problems caused by surface conditions could be avoided and with the large contrast in the subsurface materials this test would most likely work well.

If we can be of any further assistance, please let us know.

Very truly yours,

L. M. MILLER & ASSOCIATES

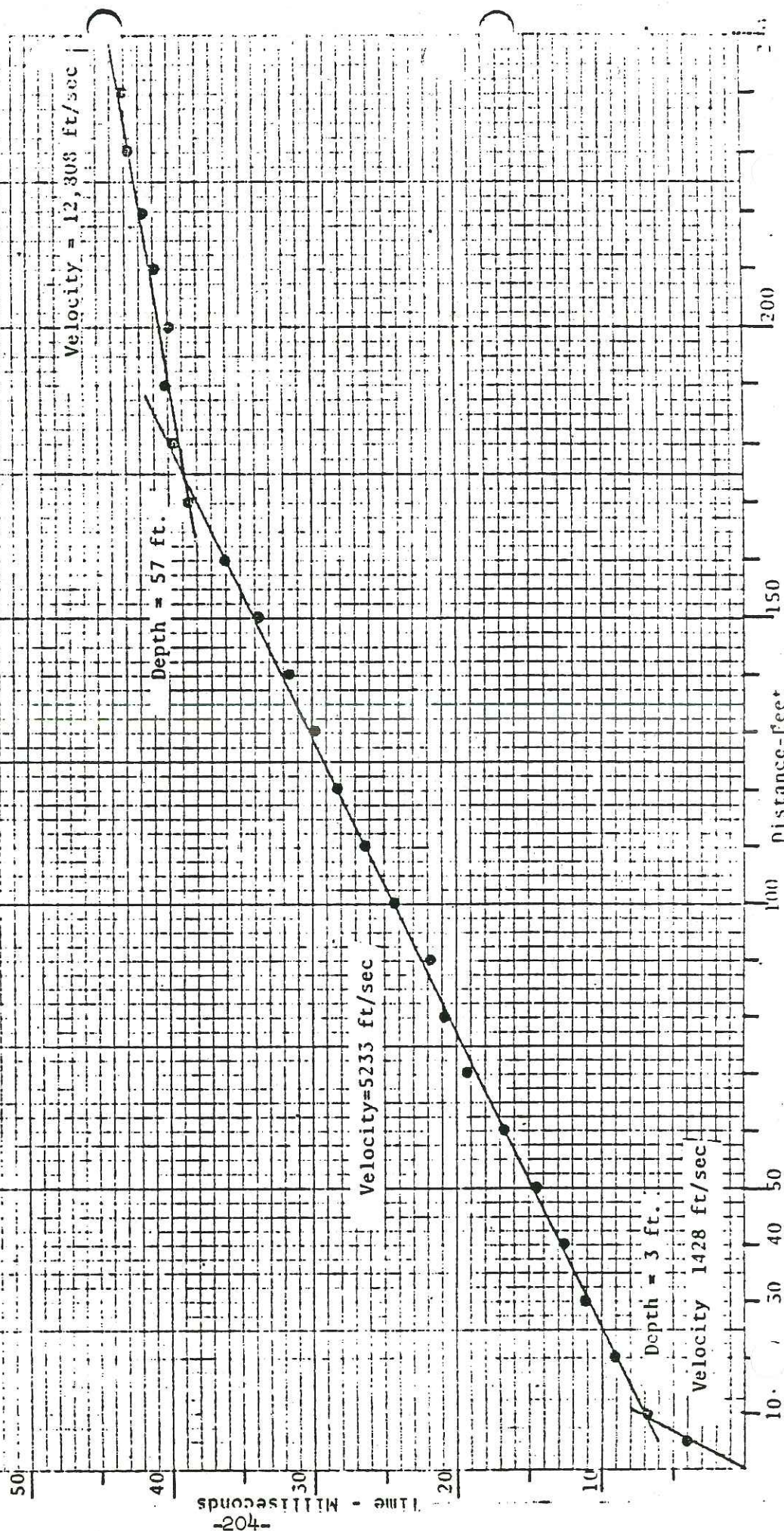
Timothy P. Wilson
Timothy P. Wilson, Geologist

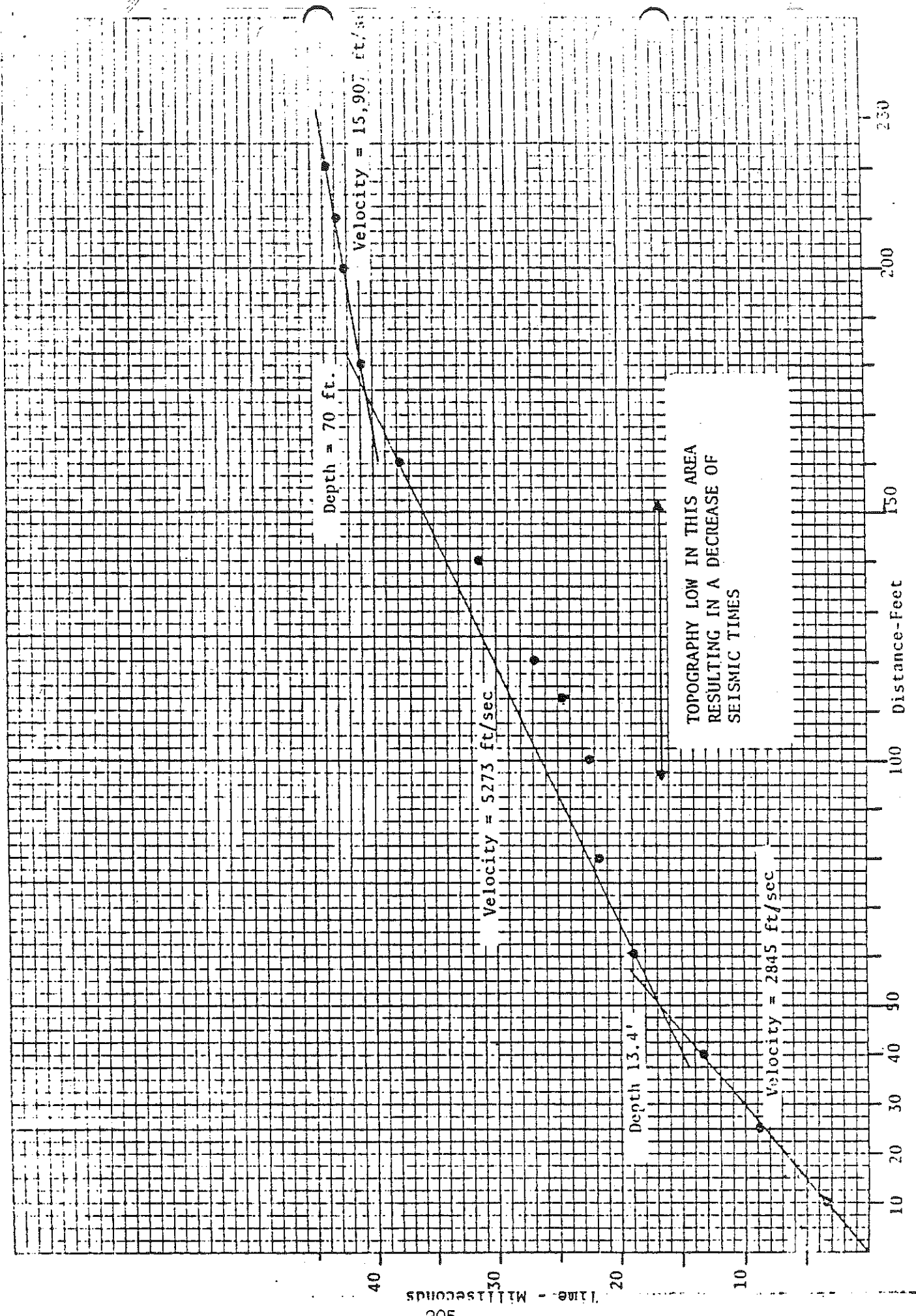
TPW:hrh

Attachments as mentioned above.

ALLEN PARK CLAY MINE
SEISMIC STATION #4

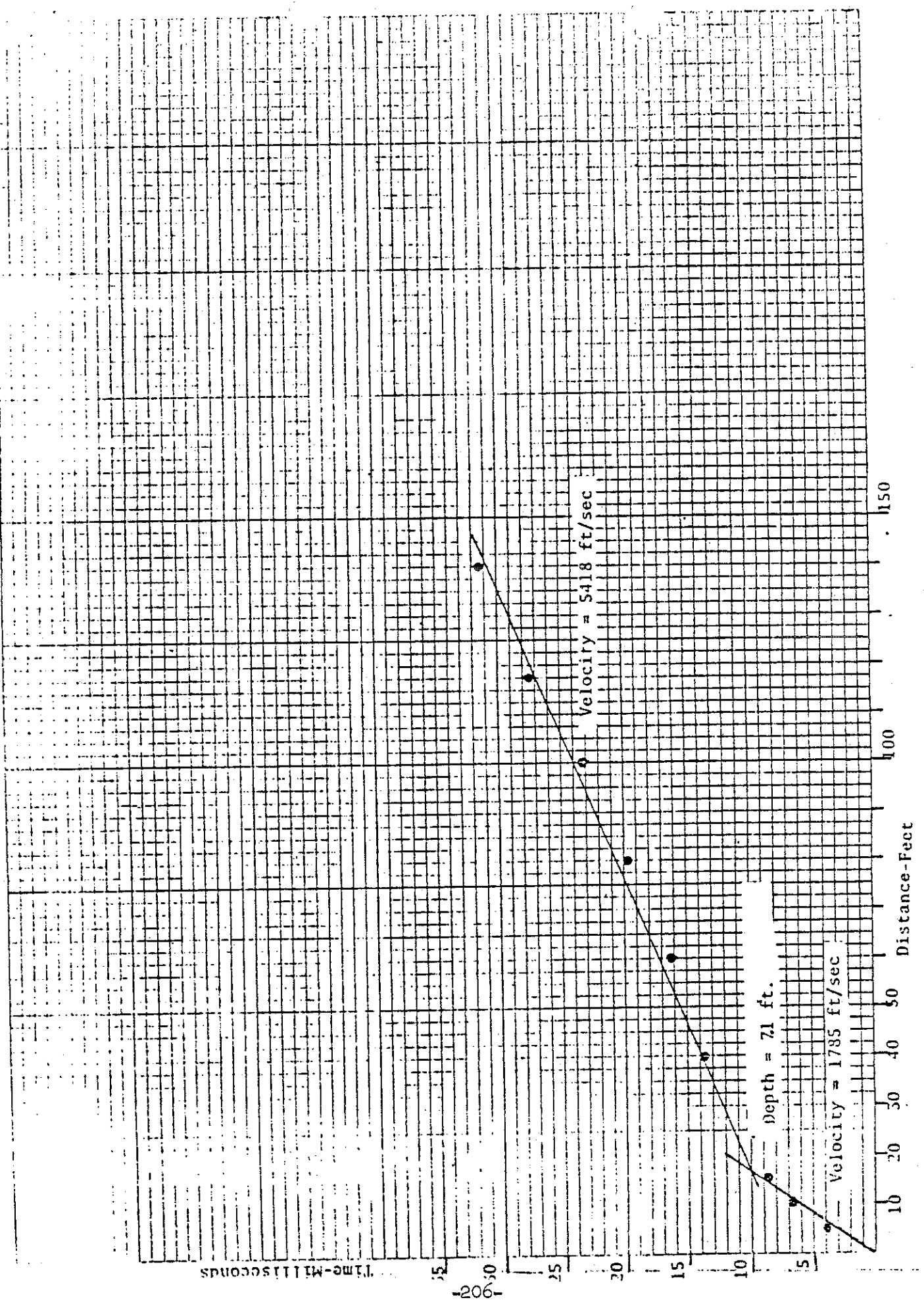
L. M. MULLER & ASSOCIATES





SEISMIC STATION #6

U. S. MILITARY ACADEMY





MICHIGAN TESTING ENGINEERS, INC.

24355 CAPITOL AVENUE • DETROIT, MICHIGAN 48239
PHONE: (313) 255-4200

SOILS EXPLORATIONS AND FOUNDATION ENGINEERING
MATERIALS TESTING AND INSPECTION
NON-DESTRUCTIVE TESTING and MATERIALS EVALUATION

June 25, 1982

Michigan Department of Natural Resources
Resource Recovery Division
P.O. Box 30028
Lansing, Michigan 48909

Attn: Mr. James Janiczek

Subject: Allen Park Clay Mine
Allen Park, Michigan
MTE File #406-15046

Gentlemen:

As requested, we have reviewed the above referenced file to determine the degree of saturation of the subsoils on the site.

The following basic soil relationships were used in this review:

$$s = \frac{wG_s}{e}$$

$$e = \frac{G_s}{\gamma_d} - 1$$

$$w = \frac{W_w}{W_s}$$

Where: s = degree of saturation (%)
 w = moisture content of soil (%)
 e = void ratio
 W_w = weight of water
 W_s = weight of solids
 γ_d = dry unit weight of soil
 G_s = specific gravity of solids
 (assumed to be 2.65 to 2.68)

Utilizing these procedures, our calculations indicate the gray silty clays on the Allen Park Clay Mine to be 100% saturated.

Mr. James Janiczek


2

June 25, 1982

If there are any questions, please do not hesitate to call.

Very truly yours,

MICHIGAN TESTING ENGINEERS, INC.


Randall DeRuiter

RD/ksb

cc: D. Miller, Ford Motor Company
W. Tomyn, Wayne Disposal

NATURAL RESOURCES COMMISSION

JACOB A. TRITTER
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DEPARTMENT OF NATURAL RESOURCES

HOWARD A. TANNER, Director

EXHIBIT G

RESOURCE RECOVERY COMMISSION

THOMAS J. DRESSING, JR.
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RESOURCE RECOVERY DIVISION

P.O. BOX 3407R
 LANSING MI 48209

ADMINISTRATION/RESOURCE
 RECOVERY SECTION

517/373-0540

PLANNING SECTION/
 HAZARDOUS WASTE SECTION

517/373-1818

GEOLOGY SECTION

517/373-0907

November 4, 1981

Mr. Marshall Austin
 Michigan Testing Engineers, Inc.
 24355 Capitol Avenue
 Detroit, Michigan 48239

RE: Permeability testing of clay soils
 Allen Park Clay Mine; Allen Park, Michigan
 Wayne County

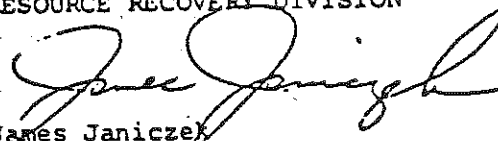
Dear Marshall:

Based on the review of the soil tests performed (grain size analysis, atterberg limits and permeability) on the clay at the Allen Park Clay Mine Landfill, it is the feeling of this office that the materials are uniform enough that no further permeability testing will be required. This portion of our evaluation has been satisfied with the information submitted.

If you have any questions, please feel free to call.

Very truly yours,

RESOURCE RECOVERY DIVISION


 James Janiczek
 Geologist

JJ:nm

cc: Shakir/Belobraidich
 Mark Young, Wayne Disposal
 Wayne County Health Department

